THE

ELECTRICAL REVIEW.

VOL. LIV. MARCH 4, 1904. No. 1,371.

ELECTRICAL REVIEW.

Vol. LIV.] CONTENTS: March 4, 1904. [No. 1,371.

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THE
UNIVERSAL ELECTRICAL DIRECTORY

1904 Edition

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ATMOSPHERIC IONS AND THE WEATHER.

THE article by Mr. John Don which we publish in this issue will, we hope, direct attention to a promising field of meteorological observation which has hitherto received very little attention in this country.

The estimation of the rate of leakage through the air from an electrically charged body was apparently started by Linss in 1887 (*Meteorol. Zeitschr.*, 4, p. 352). The subject was then taken up by the famous German physicists Elster and Geitel, who made a series of important experiments on leakage phenomena in 1900 (*Ann. d. Phy.* (4) 2, p. 425). They came to the conclusion that the leakage was due to the presence of free positive or negative electrified particles in the atmosphere. A charged body, which may be an ordinary gold leaf electroscope, when placed in a volume of air containing a large number of free positive and negative particles, attracts the particles of the opposite sign to its own charge. The charge on the electroscope is thus gradually neutralised and the leaves slowly collapse. If the charge of the electroscope is positive, the rate of leakage is a measure of the number of free negative particles in the air; and if the charge is negative, the rate of leakage is a measure of the number of free positive particles in the air.

There can be little doubt that these electrified particles in the atmosphere are the ions or free electrons produced by the dissociation or breaking-up of the molecules of the air. We know now that there are many agencies capable of effecting this dissociation of the air molecules; for example, the rays from radioactive substances, and the Röntgen rays. If a charged electroscope is placed in the neighbourhood of a radioactive substance, the leaves of the electroscope will collapse more or less rapidly according to the strength of the radioactive substance. In this case the particles projected from the radioactive substance break up the molecules of air, by impact, into positive and negative ions, and we obtain leakage phenomena exactly similar to those obtained by Elster and Geitel in their experiments with common atmospheric air. The short, irregular waves in the ether which constitute the Röntgen rays are also capable of breaking up the molecules into their constituent ions. Röntgen rays directed into the air in the neighbourhood of a charged electroscope will, like the rays from radioactive substances, cause the leaves of the electroscope to collapse. Ultra-violet light is also capable of ionising air.

The ionising agencies mentioned above, produce equal numbers of positive and negative ions, but there are some agencies at work in nature which produce an excess of one kind or the other. Lenard has shown that in the neighbourhood of waterfalls there is an excess of negative ions, and, as was to be expected, Elster and Geitel found that near a waterfall the leakage of a positively charged electroscope

was much faster than the leakage of a negatively charged one. The dashing of the waves of the sea against the shore produces an excess of positive ions in the atmosphere, the presence of a certain percentage of soluble salts in water having the effect, as shown by Lenard, of reversing the polarity of the ions liberated in the air.

This unipolar ionisation of the air directly produced by waterfalls and the dashing of the waves of the sea, is also indirectly brought about, probably on a much larger scale, by the influence of the permanent electric charge of the earth upon air containing an equal number of free positive and negative ions. The electric charge of the earth is negative, and wherever this charge produces a steep potential gradient in the surrounding air, the free negative ions are repelled and the free positive ions are attracted, and the air close to the surface of the earth becomes charged with a large excess of positive ions. The potential gradient created in the air by the earth's charge depends on the configuration of the earth's surface. The gradient will be very steep over the tops of high mountains, very gentle over extensive plains, and practically horizontal in deep valleys. What we should expect to find therefore would be a great excess of positive ions at the tops of mountains, an equal amount of positive and negative ions in flat countries, and also in deep valleys. This has been found to be the case except in the last instance, where an excess of positive ions has been found. The occurrence of an excess of positive ions in deep valleys cannot therefore be due to the separating influence of the earth's permanent charge. It has been attributed to the greater rate of diffusion of the negative ions, which thereby reach the sides of the valley sooner and are faster absorbed into the earth.

The existence of air highly charged with positive ions on the tops of mountains has been amply demonstrated. Elster and Geitel made repeated experiments in the Alps, and found that when their electroscope was charged with negative electricity, it invariably leaked much faster than when it was charged with positive electricity. On the great plain of northern Germany, however, they found that the leakage of positive and negative charges was very nearly equal.

The highly charged positive air on the tops of mountains is sometimes blown down into the valleys by wind blowing over the top of a mountain range. For example, a south wind blowing over the top of the Alps, known as the Föhn, creates such an excess of positive ions in the northern valleys, that it seriously affects the health of the inhabitants, producing what is known as Föhn sickness. Mr. Don's experiments at Peterhead afford a remarkably good illustration of the same phenomenon; he found that winds from the west, which had passed over the Grampians, produced a comparatively quick discharge of a negatively-charged electroscope, while east winds which had come over the North Sea, on many occasions, left the electroscope unaffected for hours on end.

Mr. Don also found that on the whole the leakage of his electroscope was less on rainy days than on dry days. This observation agrees with the observations made by Elster and Geitel. They found that the greatest leakage took place when the sky was clear. When dust, fog, smoke or clouds were present in the atmosphere in considerable amount, the leakage of the electroscope was greatly reduced.

The effect of dust and aqueous particles is to remove free ions from the air. Dust particles probably attract the free ions both positive and negative, and thus facilitate their recombination into neutral molecules. Aqueous particles, as Wilson has shown, form round negative and positive ions, and thus remove them as rain or clouds from the surrounding air.

We have discussed some of the great ionising agencies at work in the atmosphere, but there is good reason for supposing that there are many others. For example, we have now much evidence in support of the view that radioactive substances in very minute quantities are widely diffused in the earth's crust. Water drawn from deep wells and from mineral springs has been found to be radioactive; and air drawn from considerable depths in the ground has also shown signs of radioactivity. Now exceedingly small quantities of radioactive substances have a very powerful influence in ionising the air, and there can be little doubt that the radioactive material in the earth's crust has a great deal to do with the production of free ions in the lower strata of the atmosphere.

The ionisation of the air in the upper strata of the atmosphere is far more intense than in the lower strata, quite apart from the effect of mountain peaks explained above. Ebert has shown this by experiments made from balloons. At a height of 2,375 metres he found, on one occasion, that the leakage was 23 times as great as the leakage on the ground. As the ionic content at this height could not be explained as being due to the potential gradient of the earth's charge, intensified by the projection of mountain peaks, some other cause must be sought for. We should, of course, expect that ultra-violet light in the sun's rays would be much more powerful in the upper regions of the atmosphere, because it is rapidly absorbed by passing through great thicknesses of air. But there may also be other ionising agencies at work in the upper atmosphere. Birkeland's theory of the aurora borealis is that it is due to cathode rays emitted from the sun, which strike the upper strata of the earth's atmosphere and are focussed on the poles by the earth's magnetic field. If this theory is correct, we have to add the cathode rays from the sun to the ionising agencies at work in the upper atmosphere. But the sun has lately been suspected of containing radium in large percentage. If so, we may expect to receive into our atmosphere a considerable discharge of rays from the radioactive material in the sun, and this is still another and probably very powerful ionising agency at work in the higher atmosphere.

The question of the production of atmospheric ions and their effect on the weather and on the human constitution and temperament, ought to be one of absorbing interest to meteorologists. The apparatus necessary to make the observations is comparatively simple, and Mr. Don's experiments show how much might be learned if continuous observations of the same kind were made at all the principal meteorological stations in the British Isles. These ionometric observations would be of no less interest to medical men by helping them to understand the effect of climate on health, and perhaps enabling them to produce some of the favourable conditions artificially, by the use of the suitable ionising agents in the laboratory. It is to be hoped that Mr. Don's interesting experiments will give an impulse to this new branch of meteorology on this side of the Channel.

Tramway Depreciation.

The advent of electric traction and the subsequent abnormal development of our tramways—and correspondingly of our capital expenditure on them—has given rise to many knotty problems, not the least being the making of a correct estimate of the life of the permanent way of such an undertaking.

The loans for tramways capital expenditure under the Act of 1899 allow approximately 30 years for repayments on account of permanent way, although this cannot in any way be taken as an estimate of the life of the track. A correct estimate based on standard English traffic conditions was, of course, unobtainable where electric traction under modern conditions was of comparatively recent introduction, and it remained for "Father Time" to solve the much-discussed problem. This he has accomplished at an uncomfortably early date for those who were confiding enough to be misled into a feeling

of security, through placing too much reliance on the 30 years' period allowed for repayment of loans. The most recent addition to the ranks of the "sleepers awakened" appears to be Southampton, where a section of route put down under contract for the Corporation in 1899—1900, is to be relaid at a cost of £8,300, and it is stated that a further section of two miles will share the same fate next year. We have no exact information by us as to the particular ailment from which this section of track has suffered, but judging from the committee's recommendation, the comparatively light rails (*i.e.*, about 86-8 lbs. per yard) have not proved equal to the heavy traffic associated with electric traction.

We have previously hinted that tramway constructional work has not kept pace with the altered conditions due to the higher speeds and weights of modern cars; and even those towns, numbering about 30, which wisely put down rails weighing from 100 to 107 lbs. per yard, find two or three years sufficient to expose the weak places in their track.

If, in addition to light track-work, the concrete bed of a tramway should turn out to be unsatisfactory, then, failing reconstruction, the troubles of that system are only beginning. That concrete used in tramway work is by no means above suspicion is instanced in recent disclosures connected with some of the lately constructed L.C.C. lines.

But to return to Southampton, where the Committee recommends that the cost of carrying out the reconstruction work be met out of the depreciation and renewals fund, and, if necessary, any further amount required, out of revenue; in the ordinary course of events, it seems probable that this will extinguish the former fund, and it will then be necessary to annex the revenue of the succeeding year when further reconstructions are taken in hand. Mr. McColl, of the Glasgow Corporation tramways, suggests a provision of £450 per mile of single track per annum for depreciation, and in view of recent events, which appear to indicate an average life of track for a busy tramway system of not more than 10 years, this amount is none too much. The whole question of the re-adjustment of the proportions of the renewal fund and the depreciation fund (to provide for antiquation) appears to require immediate attention at the hands of tramway authorities.

Cable Cutting in War Times.

EVERY war makes interesting the question as to the utility of cables after hostility has begun. The belligerents in the Far East have, so far, both availed themselves as adherents to the St. Petersburg Telegraph Convention, of the powers accorded them under Article 8 to prohibit the use of certain routes and to restrict the freedom of public telegraphing, as well as exercising a rigorous censorship which practically renders the news received from the seat of war, if not to a great extent valueless, at all events, very distracting. It will be found, by referring to our "Interruption List," that the Vladivostock-Nagasaki and Port Arthur-Chefoo cables are "closed" to the public entirely, but communication with Nagasaki is possible, *viâ* Formosa, and from Shanghai, the Shanghai-Nagasaki cables being still intact. In the same manner Port Arthur may be reached through the Chinese landlines *viâ* Neuchwang. On the other hand, landlines in Korea have been cut in various places, viz., between Seoul and Masampo, Seoul and Gensan by the Japanese, and between An-ju and Ping-Yang by the Russians. During the closing of the Vladivostock cable, telegrams are diverted *viâ* Kiakhta.

It will be seen, therefore, that up to date cables have not been cut either by the Japanese, who are supposed to have the command of the sea, or by the Russians wherever they may be, and the multiplicity of routes still leaves communication with all places practically intact. The value of alternative routes appears to be, to some extent, demonstrated, and the policy of completing during peace times "likely" and apparently "unlikely" connections, which we have often advocated, is shown to be a sound one. The British chain of strategic cables is not yet complete, as was shown to the Cables Committee formed to consider and report upon this question some years ago, but there is no doubt there will be another example shown during this war of the necessity of carrying out certain recommendations made by that Committee at a near date, and during the period of peace now existing.

The Repulsion Motor.

THE present issue contains the concluding article of a series by Mr. F. Creedy on the "Circle-Diagram of the Repulsion Motor." The author makes use of a modification of Mr. Steinmetz's methods, which consists essentially of the introduction into the subject of what is called by mathematicians the "scalar part" or product. By the use of this method the following advantages are said to be secured:—

All formulæ are rendered easily intelligible geometrically, so that geometrical constructions for every quantity required can be obtained without any difficulty, and thus the laborious calculation from formulæ, which is an unpleasant adjunct to Mr. Steinmetz's, and other analytical methods, is avoided.

It is claimed for this method that it is more powerful and has greater mathematical elegance than either the ordinary analytical method or the geometrical method, so that it is as easy to take such things as iron losses, &c., into account as to leave them out. Thus greater rigour is secured in the results. It furnishes a routine method by which, when once in possession of the fundamental equations (and they are very easy to get), the graphic theory of any machine may be worked out in a very short time. Thus the behaviour of any new machine, or modification of an old one, can easily be studied before it is constructed.

Whether these somewhat extensive claims are really satisfied, must be left for our readers to determine for themselves by actual trial; we commend the system to their notice in the hope that it may prove of service to them in simplifying this difficult subject.

Radium Emanation in Springs.

THE existence of a radioactive substance in the Bath and Buxton springs was some time ago demonstrated by Strutt and Blythswood, and now Himstedt in the February number of the *Annalen der Physik* shows that all spring water when it issues from the earth contains a certain amount of radioactive substance which he has identified with the emanation of radium. Petroleum drawn direct from a spring contains a still larger quantity of the radium emanation—20 times as much as spring water. Himstedt discovered the existence of a radioactive substance in these fluids by forcing air through them, and then testing its conductivity with the electroscope. In every case he found that its conductivity was greatly increased. He showed that this increased activity was due to a radioactive substance which had been absorbed into the air from the active fluids, by passing the active air through inactive fluids and imparting radioactivity to the latter. The radioactivity of fluids drawn from springs is, however, not permanent, but falls off rapidly when they are exposed to the air. The water of running brooks, for example, is not radioactive. Hot water springs are much more radioactive than cold springs. The most radioactive of all the springs tested by Himstedt was the hot Murquelle at Baden-Baden. Assuming that the healing property of thermal springs is due to the presence in them of radium emanation, and knowing, from Himstedt's experiments, that this emanation rapidly evaporates when the water is exposed to the air, it follows that the waters of these springs, if stored for any length of time, must lose their medicinal effect. The moral of this is that we must go to the spring to take our mineral waters, and not purchase them from the chemist. Another important conclusion to be drawn from Himstedt's experiments is that at great depths in the earth, radium must exist in considerable quantities. Himstedt also suggests that the internal heat of the earth may be due to radium.

ON THE CIRCLE-DIAGRAM OF THE REPULSION MOTOR.

Containing a General Method of Deducing the Graphic Theory of any Alternating Current Apparatus.

By F. CREEDY, A.C.G.I.

III.—Complete Diagram for any Position of the Brushes.

The constructions given in the second article for the current, power-factor, torque, and speed, completely determine all the curves of the motor, so long as λ is constant. From the curves relating these quantities, all the other curves of the motor, such as the output and efficiency curves, may be determined. Constructions for these on the diagram, however, follow immediately from the preceding, as follows :—

Output.—Since output = torque by speed, we have output

$$= \frac{SI}{OI} \cdot OI \cdot IP = SI \cdot IP \text{ (see fig. 9).}$$

Input $= IR$ obviously.

Efficiency $= \frac{SI \cdot IP}{IR}$.

Secondary Current.—From equation (1),

$$\mathbf{i}_1 \sin\lambda = \frac{\mathbf{e}_0 - \mathbf{i}\,Z}{Z_0} - \mathbf{i}.$$

Therefore $\mathbf{i}_1 \sin\lambda$, which is a measure of $\mathbf{i}_1$ if λ is constant, is the vector difference of $\frac{\mathbf{e}_0}{Z_0} - \mathbf{i}\,\frac{Z}{Z_0}$ and $\mathbf{i}$. Now $\frac{Z}{Z_0}$ acting on $\mathbf{i}$ turns it through a constant angle, and alters its length in a constant ratio. Consequently, since $\mathbf{i}$ moves on a circle, so will $\frac{\mathbf{e}_0}{Z_0} - \mathbf{i}\,\frac{Z}{Z_0}$, since $\frac{\mathbf{e}_0}{Z_0}$ is constant. This circle is shown in fig. 14. In practice, we may obtain the secondary current with sufficient accuracy, by taking the vector difference of $\mathbf{i}$ and $\frac{\mathbf{e}_0}{Z_0 + Z}$ a vector lying on this circle.

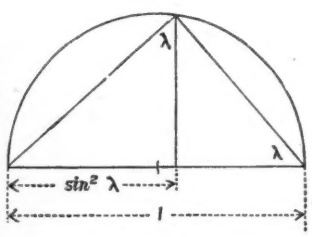


Fig. 11.

Effect of Varying λ.—In order to investigate this we must study equation (3), which may be considered the fundamental equation of the repulsion motor, more in detail.

The equation was in its original form,

$$\mathbf{i}\left(\sin\lambda - \frac{(Z_0+Z)(Z_0+Z_1)}{Z_0^2 \sin\lambda}\right) + \mathbf{e}_0\,\frac{Z_0+Z_1}{Z_0^2 \sin\lambda} = \mathbf{i}\,j\,k\cos\lambda.$$

It is now convenient to introduce two fresh constant versors, M and N, instead of A and B, formerly used. If we put

$$N = \frac{Z_0 + Z_1}{Z_0^2} \text{ and } M = (Z_0 + Z)\,N,$$

we get

$$\mathbf{i}\left(\sin\lambda - \frac{M}{\sin\lambda}\right) + \mathbf{e}_0\,\frac{N}{\sin\lambda} = \mathbf{i}\,j\,k\cos\lambda.$$

Thus $A = \sin\lambda - \frac{M}{\sin\lambda}$ and $B = \frac{N}{\sin\lambda}$.

Thus we have (see equations (4) and (5))

$$\text{Standstill current} = -\,\mathbf{e}_0\,\frac{B}{A} = \mathbf{e}_0\,\frac{N}{M - \sin^2\lambda}.$$

Vector to centre of current circle

$$= -\,\mathbf{e}_0\,\frac{B}{[A]_1} = \mathbf{e}_0\,\frac{N}{[M]_1 - \sin^2\lambda}.$$

Vector diameter of torque circle

$$= \mathbf{t} = \mathbf{e}_0\,\frac{\bar{j}\,\bar{Z}_0^2}{[(Z_0 + Z)\,\bar{j}\,\bar{Z}_0^2]_1}.$$

These may easily be calculated by substituting for M and N the values given above. The best way to multiply or divide complex numbers is to express them in the polar form r cis θ, and then apply the rules given in the preliminary article. We can easily transform a complex number from the rectangular to the polar form, or *vice versâ*, by setting it out as a vector, and measuring the quantities required.

From the above expression for the vector to the centre of the current circle, we see that the only effect an increase of λ has on it, is to decrease the denominator, and thus, as this latter is a pure real, to increase the length, without altering the direction of the vector. Thus, if we increase λ, the centre of the current circle moves away from the origin along a straight line which has the direction of $\mathbf{e}_0$ N. Thus if in fig. 9 we vary λ, we get a series of circles with their centres on a straight line, and all tangent at the origin, as shown in fig. 12.

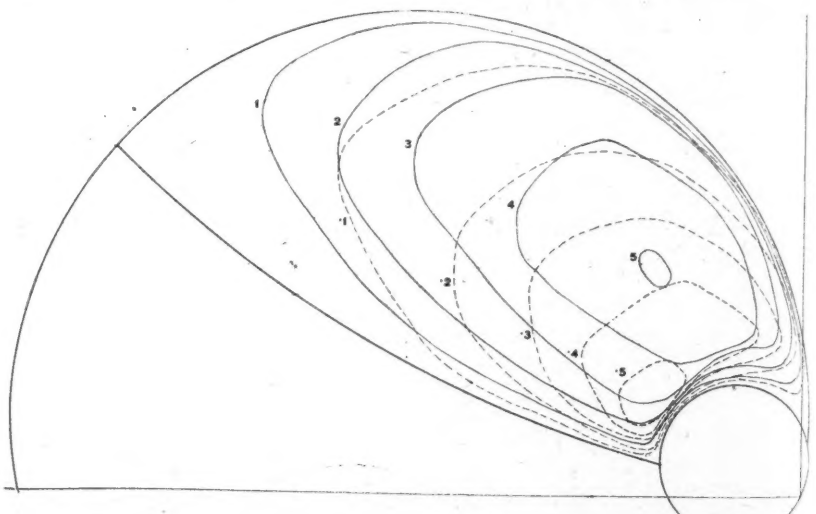


Fig. 13.

In order to get a clear and complete idea of the effect of varying λ, the next thing to do is to draw the speed-lines or the curves on which $\mathbf{i}$ moves, if we keep the speed constant and vary λ.

To draw the Lines of Constant Speed.—Multiplying the last equation through by $\sin\lambda$, and transposing, we get

$$\mathbf{i}\,(\sin^2\lambda - j\,k\sin\lambda\cos\lambda) = \mathbf{i}\,M - \mathbf{e}_0\,N. \qquad (7)$$

Before going further we may notice that if $\lambda = 0$, *i.e.*, if the brushes are perpendicular to the stator axis, we have

$$\mathbf{i} = \mathbf{e}_0\,\frac{N}{M} = \frac{\mathbf{e}_0}{Z_0 + Z}.$$

This current, which is of fundamental importance in the present theory, will be called *the magnetising current*. It is obviously the same whatever the speed, consequently all the lines of constant speed pass through the point corresponding to it on the diagram.

Also if $\lambda = 90°$, *i.e.*, the brushes are parallel to the stator axis, we have

$$\mathbf{i} = \mathbf{e}_0 \frac{\text{N}}{\text{M} - 1}.$$

This current is of similar importance to the last and will be called the *short-circuit current*.

The lines of constant speed obviously all pass through the point corresponding to this current also.

Writing in equation (7) $\sin^2 \lambda = \frac{1}{2}(1 - \cos 2\lambda)$ and $\sin \lambda \cos \lambda = \frac{1}{2} \sin 2\lambda$, and re-arranging,

$$\mathbf{i}\{\tfrac{1}{2}(\cos 2\lambda + \jmath k \sin 2\lambda) - (\tfrac{1}{2} - \text{M})\} = \mathbf{e}_0 \text{N}.$$

$$\therefore \quad \frac{2 \mid \mathbf{e}_0 \text{N} + \mathbf{i}(\tfrac{1}{2} - \text{M}) \mid}{i} = 1$$

and λ is eliminated.

The two vertical lines in the above equation form the usual notation for the modulus or absolute magnitude of a complex number. Although the use of an italic letter is very convenient to denote the magnitude of a single symbol, it is obviously inapplicable to a sum of symbols such as occurs above. Multiplying through by i and squaring

$$4 \mid \mathbf{i}(\tfrac{1}{2} - \text{M}) + \mathbf{e}_0 \text{N} \mid^2 = i^2,$$

which may, by suitable transpositions and substitutions, be written in the form

$$\mid \mathbf{i} - \mathbf{r} \mid^2 = \text{constant},$$

which asserts that the distance of the extremity of $\mathbf{i}$ from a given point, denoted by $\mathbf{r}$, is constant, and is therefore the equation of a circle.

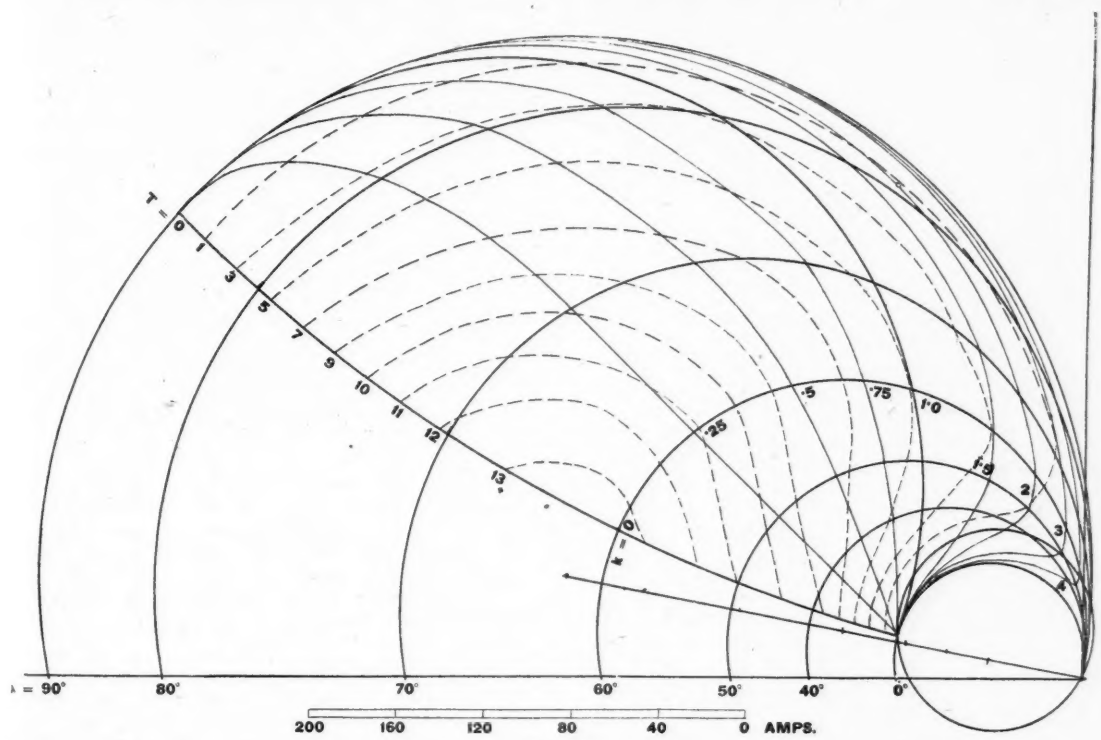


Fig. 12.

Writing the sine and cosine in their exponential forms, *i.e.*,

$$\cos 2\lambda = \tfrac{1}{2}(\text{cis } 2\lambda + \text{cis } -2\lambda)$$
$$\text{and } \jmath \sin 2\lambda = \tfrac{1}{2}(\text{cis } 2\lambda - \text{cis } -2\lambda),$$

and again re-arranging,

$$\mathbf{i}\{(\tfrac{1}{4}(1 + k)\text{cis } 2\lambda + \tfrac{1}{4}(1 - k)\text{cis}(-2\lambda) - (\tfrac{1}{2} - \text{M})\} = \mathbf{e}_0 \text{N}.$$

It is useless to proceed further with the general investigation, as the result is not a simple curve but a quartic. If we know the standstill current curve and the curve for some other speed (say synchronism) so as to determine the scale, we can draw all the curves of constant speed by calibrating the current circles in terms of the speed by the construction given above (fig. 9), and drawing the curves through the points so obtained, as is done in fig. 12.

I therefore propose to give separate investigations for the cases of $k = 0$ and $k = 1$, showing that in these two cases the speed curves are circles. In fact, when $k = 0$ or ± 1, the curve is a circle, and, when $k = \infty$, it is a pair of circles. Putting $k = 1$ in the last equation and transposing,

$$\tfrac{1}{2}\mathbf{i}\,\text{cis } 2\lambda = \mathbf{e}_0 \text{N} + \mathbf{i}(\tfrac{1}{2} - \text{M}).$$

Dividing by $\frac{1}{2}\mathbf{i}$,

$$\text{cis } 2\lambda = \frac{2(\mathbf{e}_0 \text{N} + \mathbf{i}(\tfrac{1}{2} - \text{M}))}{\mathbf{i}}.$$

Now if two vectors are equal their lengths are equal. The length of cis 2λ is 1.

This circle passes through the two points A and B (fig. 14) as do all the other speed lines, and, like them, is tangent to the two extreme current circles corresponding to $\lambda = 90°$ and $\lambda = 0$, which together form the locus of infinite speed. It is obviously completely determined by these conditions.

Putting $k = 0$ in equation (7), we have

$$\mathbf{i} \sin^2 \lambda = \mathbf{i}\,\text{M} - \mathbf{e}_0 \text{N}.$$

This equation is of precisely the same form as that of the current circle, and will be treated in exactly the same way (see second article).

Multiplying by $\jmath \bar{\mathbf{i}}$ and taking only the real part of the product we get

$$[\bar{\mathbf{i}}(\mathbf{i}\jmath\text{M} - \mathbf{e}_0 \jmath \text{N})]_1 = 0,$$

the equation of a circle passing through the origin. We already know three points on this circle, viz., the origin, the magnetising current point A, and the short-circuit current point B, so it is completely determined.

By the process used in the second article to find the centre of the current circle, we may ascertain that the vector to the centre of this circle is $\frac{1}{2}\mathbf{e}_0 \frac{\jmath \text{N}}{[\jmath \text{M}]_1}$.

This vector represents that radius of the circle which passes through the origin. It has the direction of $\jmath \mathbf{e}_0 \text{N}$. Now, as we saw above, the direction of the line of centres was that of $\mathbf{e}_0 \text{N}$. Therefore, since $\jmath$ turns a vector through a right angle, the line of centres is perpendicular to that

radius of the standstill current circle, which passes through the origin. Therefore, since it passes through the origin also, *the line of centres is tangent to the standstill current circle at the origin.*

In the last equation but one, dividing by $\mathbf{i}$ we get—

$$\sin^2 \lambda = \frac{\mathbf{i}\,\mathrm{M} - \mathbf{e}_0\,\mathrm{N}}{\mathbf{i}}.$$

writing $\mathrm{M} = m \operatorname{cis} \mu$, and dividing by m,

$$\frac{1}{m} \sin^2 \lambda = \frac{\operatorname{cis} \mu \left(\mathbf{i} - \mathbf{e}_0 \frac{\mathrm{N}}{\mathrm{M}} \right)}{\mathbf{i}}.$$

Thus $\sin^2 \lambda$ may be determined by precisely the same construction used before for the speed. In fact, in fig. 14, $\sin^2 \lambda = \frac{\mathrm{A\,S}}{\mathrm{O\,S}}$. It may be expressed by a single line in precisely the same way as may the speed. From $\sin^2 \lambda$ we may determine λ, either by tables, or, better, by the subsidiary construction shown in fig. 11. Considerable care, however, is requisite in using these constructions, as a small error in them may produce a large error in the result.

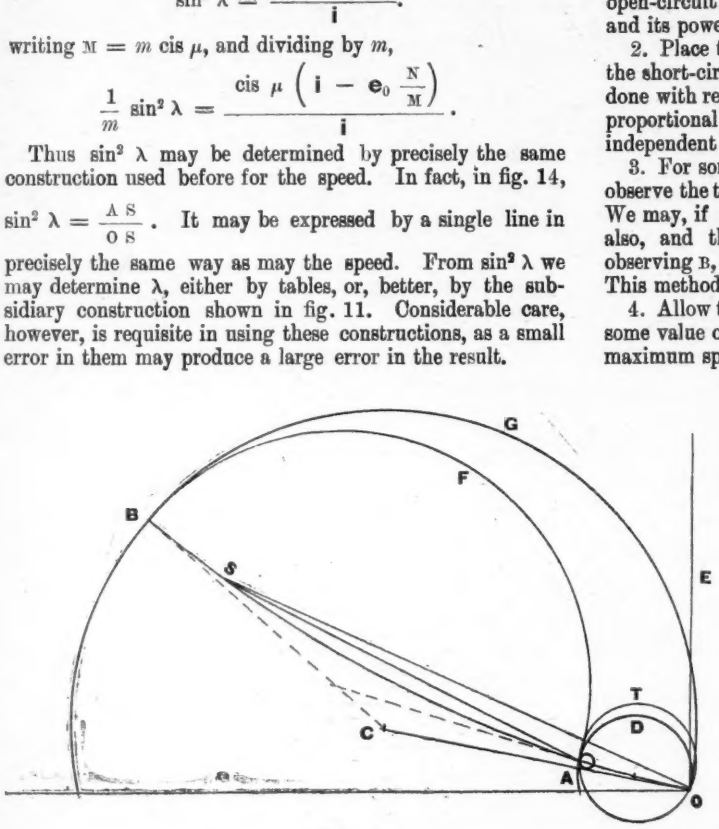


Fig. 14.

We may next draw in the lines of constant torque, as shown in fig. 12. If we know the torque for a known value in λ, and a known speed, we have the scale; for we can find the scale for any other value of λ from the construction of fig. 10. We can now calibrate our current circles in terms of the torque, and draw in the torque lines. As the torque gets less, these lines approximate to the current circles corresponding to $\lambda = 90°$, and to the torque circle, which, together, form the locus of zero torque, and, therefore, also of zero output and efficiency.

Other interesting curves are the lines of constant output and efficiency. The output lines may easily be drawn by taking note of the fact that as we go along a line of constant speed, the torque at any point is a measure of the output, to a scale depending on the speed to which the line corresponds. These lines are best drawn on another sheet by the use of tracing paper.

The efficiency lines are easily drawn by finding points along the lines of constant input (which are, of course, straight lines perpendicular to O E, fig. 14).

The curves of constant output and efficiency are shown in fig. 13. When I commenced to calculate this motor, I did not think the efficiency would turn out so low. The efficiency lines in fig. 13 must be regarded as characteristic of this motor alone, not of repulsion motors in general. I chose the constants to show the leading current obtainable in some motors at very high speeds.*

The constants of the motor whose diagrams are shown to scale in all the figures from fig. 7 onwards, are :—

$$z_0 = \cdot25 - 1\,j = 1\cdot036 \operatorname{cis} - 76°$$
$$z = \cdot03 - \cdot09\,j = \cdot095 \operatorname{cis} - 72°$$
$$z_1 = \cdot1 - \cdot1\,j = \cdot1414 \operatorname{cis} - 45°$$
$$\mathbf{e}_0 = 100$$
$$z_0 + z = \cdot28 - 1\cdot09\,j = 1\cdot136 \operatorname{cis} - 75\cdot5°$$
$$z_0 + z_1 = \cdot35 - 1\cdot1\,j = 1\cdot165 \operatorname{cis} - 72°.$$

* In the figures, T is in synchronous KW. and output in KW. In fig. 13 the dotted lines are the efficiency lines.

Testing of the Repulsion Motor.—The above investigations render the testing of the repulsion motor a very simple matter. Obviously, since the properties of the motor depend on six constants, six observations should be sufficient. The best way to proceed seems to be as follows :—

1. Place the brushes perpendicular to the stator axis, or open-circuit the rotor, and observe the magnetising current and its power factor. This gives the point A (fig. 14).

2. Place the brushes parallel to the stator axis and observe the short-circuit current and its power factor. This may be done with reduced voltage, if necessary, since the current is proportional to the impressed E.M.F. and its power factor independent thereof. This gives the point B.

3. For some known value of λ (45° is, perhaps, the best) observe the torque at standstill. This gives the torque scale. We may, if we choose, observe the current and power factor also, and thus get the standstill current circle without observing B, which may be found afterwards by construction. This method, however, is less accurate than the former.

4. Allow the motor to run up to its maximum speed for some value of λ, which should be small, in order to keep the maximum speed, and hence the friction and windage losses, down. Observe the current and power factor. This gives us (approximately, for the method neglects the friction and windage losses) a point on the torque circle, since this latter is the locus of zero torque, and, therefore, of maximum speed of the machine as a motor. This point, together with the points A and O, completely determine the torque circle.

We may now proceed to construct our diagram. Setting out the points A and B (fig. 14), we draw the standstill current circle through them and the origin. Tangent to this circle at the origin, we draw a straight line O C, which is the locus of the centres of the current circles. Next, we calibrate the standstill current circle in terms of λ by the construction given, thus finding a point on each circle. We now draw the circles, passing through this point and the origin, and having their centres on the given straight line. Passing through the points A and B, and tangent to the circles B G O and A D O, corresponding to $\lambda = 90°$ and $\lambda = 0$ respectively, we draw the circle of synchronous speed A F B, and then, if we choose, put in the speed lines. We next draw the torque circle A T O, passing through the points A and O and the point on it we have just determined experimentally. Finding the scale by means of our torque observation, we next calibrate a suitable number of current circles in terms of the torque, and put in the torque lines, after which we may put in as many other kinds of lines as we please.

Some further information on the above subject may be found in a very able article entitled "Das Kreisdiagramm des Repulsionsmotors," by Herr M. Osnos, published in the *Electrotechnische Zeitschrift* for October 29th, 1903. I am indebted to this author for the correction of an error in one of my formulæ.

Throughout the above work, which was done at the Central Technical College, I have received valuable assistance from my friend Mr. W. G. H. Cam, whom I here desire to thank. I hope at some later date to be able to give further applications of the vector algebra of complex numbers to electrotechnics.

SOUTH AFRICAN NOTES.

[FROM OUR DURBAN CORRESPONDENT.]

Pietermaritzburg (Natal).—The construction of the electric tramway track by the contractors, Messrs. Strong & Moore, of the above town and Durban, is being rapidly proceeded with, the 3½ miles of girder rails (90 lbs. to the yard) being about complete. The laying of the "Vignoles" rails (60 lbs. to the yard), about 4 miles of which are to be laid in the suburbs, is just commencing. We hear that the points and crossings, which are being supplied by Messrs. Hadfield's, are just shipped, as also are the six "Brush

eight-wheel bogie cars. The overhead equipment is being supplied by Messrs. R. W. Blackwell, of London, and is expected to arrive very shortly. The rails are laid on a concrete bed, with short longitudinal rails under the joints bolted to the track, and the girder track throughout will be paved with granite setts, the bonding being effected by "Crown" bonds. The power station building and plant is practically complete, and the car-shed is well in hand. It is hoped before the end of the year to have a section running.

East London (Cape Colony).—The contract for the tramway extension of two miles length for the above municipality has been given to Messrs. Strong & Moore, of Durban and Maritzburg, and is awaiting the sanction of the Government before a start can be made.

Durban (Natal).—The borough electrical engineer's report for month ending January 31st shows that the demand for current is well maintained. There were 89 applications made, equal to 4,800 lamps, making a total to date of 102,747 lamps. There were 34 new connections made, making a total number of 2,209 consumers. The number of units consumed was 92,497. The total number of power connections is 107. The use of electric motors is becoming very popular, the Corporation having just installed one 500-volt D.C. motor of 100 H.P., and one of a smaller size, for use in connection with the sewage works. In addition to this, eight applications have been made for motor connections amounting to 56 H.P.

Ladysmith (Natal).—The Electric Light Committee of the Ladysmith (Natal) Town Council is recommending a reduction in the price of current on and after March 31st, 1904, as follows:—

Consumers up to 25 units	.. ..	..	1s. per unit.	
,, from 25 to 50 units	..	..	1s. ,,	less 3 per cent.
,, ,, 50 ,, 100 ,,	..	..	1s. ,,	,, 5 ,,
,, ,, 100 ,, 500 ,,	..	..	10d. ,,	
,, ,, 500 ,, 1,000 ,,	..	..	8d. ,,	

The financial position of the department, up to January 25th, 1904, is as under:—

To debentures issued at 5½ per cent.	£13,000
Consumers for wiring and current	628
Materials in stock	40
Street lighting from September 12th, 1903, say	125
Town Hall lighting, say	10
	£13,803
By commission on raising money	£271
,, Parliamentary Bills and legal charges	75
,, Printing	35
,, Interest on debentures to date	789
,, Wages	568
,, Plant	9,681
,, Power station	1,000
,, Engineer	389
,, Tradesmen's account	466
	£13,274
Balance	£529

Against which must be debited the following amount for—

Contractors' accounts, &c.	£884
Deducting balance as shown	529
Leaving a debit of	£355

Boksburg.—A contemporary says that the T.C. has resolved to accept a draft contract for lighting the town by electricity. Energy, it is stated, will be supplied at 8d. per unit, and to Germiston at a price not exceeding 1s.

INSTITUTION OF ELECTRICAL ENGINEERS.

MANCHESTER ELECTRIC TRAMWAYS.

Discussion before the Manchester Section on Mr. McElroy's paper.

Mr. Cowan (chairman) in opening the discussion said he thought all were agreed that the tramway service in Manchester was a great boon.

Dr. Rhodes stated that with the minimum radius of 35 ft. for curves and a 5 ft. 6 in. wheel base there would be a very serious grinding action. He calculated that for 5 ft. 6 in. wheel base the least radius should be 36 ft. 3 in., and was of opinion that it was very advisable to see that the radii of the curves were made to suit the wheel base. Some towns have had so much trouble on this point that they are discussing the question of altering the wheel bases of their cars. Speaking of cars, he said the Manchester Corporation were very wise in rejecting the reversed staircase; the fact that the driver cannot see what goes on at his left hand is responsible for many minor accidents. There is also on this type of car a tendency to crowd a few extra seats at the extreme ends of the car, and this causes "hogging" of the car bodies and a swaying action of the car when going round curves. On referring to the subject of lifeguards, he said he considered the "cow-catcher" type a very bad one. The "hanging-gate" type was the only one he could advocate. Brakes should be discussed from the point of view of £ s. d., and he would like to see wheel brakes cast away altogether, as they were a nuisance and a source of expense; even with the best drivers skidding takes place on greasy rails and wears both wheels and track. For actual service use he preferred some kind of track brake. The brake shoe must be softer than the rails, and with this type there is no skidding of wheels and no friction of hard wheels on the track, and the life of both wheels and track is thereby lengthened.

Mr. Sheffield disagreed with the author and with Dr. Rhodes on the subject of reversed staircases. If the driver stands in his proper position and sees at right angles on each side, a range of 180° is all he can be expected to take notice of. As to the wear and tear of the old rails used on the Manchester system before the introduction of electric traction, he would ask if this was due merely to skidding or had the weather not had some share in it as well.

Mr. Giles thought that as the curves with 35 ft. radius wear so very rapidly (with cars having 5 ft. 6 in. wheel base) from 1¼ in. to 1⅝ in. groove, it was evident that the trams did *not* run with the 1¼-in. groove, but with the 1⅝ in. He had yet to find out that section insulators were the weak spot in the overhead work; there were firms making good fittings for this work, and he considered it quite as strong as the other portions of the equipment. He was of opinion that lifeguards are essential, as it is not always possible for drivers to see what obstacles are in their way; therefore, although Mr. McElroy had said that the best lifeguard was a good brake, that did not really do away with the necessity for the guard.

Mr. Atchison referred to the use of pitch grouting on the Manchester system for the road setts, and thought there must be trouble in summer through pitch getting on the lines. In some towns frogs of the "trailing" type had been tried to do away with the necessity for "point boys," and had been found satisfactory. Section insulators must always be anchored, and he had noticed that in Manchester they were anchored to the poles; he thought this arrangement provided extra wires for the trolley to become entangled in if it came off. A 5 ft. 6 in. wheel base allows cars to "gallop." He thought that if flats were formed on chilled cast wheels there would be more flats on the steel tires, because if there is a better braking effect there must be more wearing.

Mr. Taite remarked that in London centre poles were considered an advantage, as lighting poles were placed in the centre even of narrow streets to divide the traffic. He had a preference for the reversed type of staircase.

Dr. Bowman was in favour of rails being welded up, as tramway rails, being buried in the ground, were not subject to the same variations of temperature as railway lines, and, therefore, expansion and contraction caused no serious trouble. He agreed with Dr. Rhodes, that it was better to wear the wheels rather than the track, as they are so much more easily replaced.

Messrs. Moore and Knowles also spoke.

In reply, Mr. McElroy said that in Manchester the rails were butted up close, and there had never been any trouble from expansion; he believed Dr. Bowman's explanation to be the right one. The track was worn very greatly, especially in a city like Manchester, by the ordinary traffic of the streets, as well as by the trams themselves. His experience had shown that section insulators *are* the weak spot in a line. Pitch grouting has the great advantage of keeping the track water tight, and if it gets on the lines a bit on a hot summer's day that is not a very serious consideration. He thought centre poles were an obstruction, except in very wide streets. The energy consumption on the small cars was 0·9 unit per car-mile, and on the bogie cars, 1·4 unit per car-mile. "Continuous" rail joints were to be tried on one route.

A very hearty vote of thanks was accorded to the speaker.

MANCHESTER SECTION ANNUAL DINNER.

On Friday, February 26th, the annual dinner of this Section was held at the Grand Hotel, nearly 90 members and visitors being present. Entertainment, which appeared to be much appreciated, was provided by Mr. A. S. Giles (member), who sang several songs, and by Mr. G. Crews, who gave musical sketches and songs of a comic nature.

The toasts of "The King," and "The Queen, Prince and Princess of Wales, and the Rest of the Royal Family," were proposed by the Chairman (Mr. E. W. Cowan).

Mr. Miller, who proposed "The Institution of Electrical Engineers," remarked that the Institution is 33 years old. About sixteen years ago it changed its name, and now there are members all over the United Kingdom, and two local sections exist in the Britain beyond the seas. One of the best features of the work done in recent years by the Institution was the founding of these local bodies, amongst which there was a healthy rivalry, and the Manchester Section occupied a prominent position. The chairman, in reply, said the members of the Manchester Section could congratulate themselves on having established a society which was worthy of the importance of the electrical industry in and around Manchester. Electrical engineers to-day were living in an age of high speed—high speed in methods of transport, high speed in methods of communication and of production. He hoped trade would improve before long, and thought he saw signs of it. He looked forward to the time when electricity would be reduced in price to three or four units a penny. He also looked forward to the time when electric cars and all the overhead work would be abolished—to the time when the roads would be paved with smooth hard cement, and every vehicle propelled by a motor, smokeless and scentless, and no horses allowed within the city.

Dr. Bowman proposed "Our Guests," Mr. E. M. Lacey responding.

The "Scientific and Technical Societies of Manchester" was proposed by Dr. Schuster, and Mr. A. Saxon in replying, said he should like to see a movement inaugurated by the various societies to provide a building where their various libraries could be kept, and where they could all hold their meetings.

ENERGY DISTRIBUTION TO SUB-STATIONS.

By C. A. Smith, B.Sc.

(*Abstract of Paper read at Birmingham, January 27th*, 1904.)

The author pointed out that although the possibility of supplying electricity at a low cost by the use of producer gas had been before electrical engineers for some years, no large gas-driven plant had been erected, presumably because engineers distrusted gas engines for driving alternators. They might be used, however, for driving direct current generators in sub-stations, the gas being transmitted to the latter from a central station. The author quoted from a paper by Mr. H. A. Humphrey to show that in a power station of 20,000 E.H.P., with Mond gas producers and ammonia recovery plant costing £4·62 per KW., electricity could be generated at a works cost of 0·082d. to 0·241d. per unit sold, according to load factor and cost of coal.

In the paper the author compares the cost per unit at the sub-station switchboard when energy is transmitted electrically from a gas-driven power station three miles from the centre of the area supplied, and the corresponding cost when gas is transmitted from the same station to drive gas engines coupled to dynamos in sub-stations, the estimated future demand of the city of Birmingham for lighting, traction and motive power being taken as a basis. This amounts to 22,000 KW., requiring, with reserve plant, losses, &c., gas engines of 40,000 B.H.P. The load is assumed to be divided between five sub-stations of 4,400 KW. each, with a load factor of 25 per cent.

Slack can be obtained at 5s. per ton; allowing for a return of 4s. 6d. per ton for the ammonia recovered (present market price, 8s.), and labour charges 3s. 6d. per ton of coal, the net cost of fuel is 4s. per ton. At 70 cb. ft. per B.H.P.-hour, and with an output of 60½ million units per annum, the net cost of fuel per unit is 0·032d., neglecting transmission losses. The capital cost of the 22,000-KW. plant is taken at £100,000; land and buildings, £40,000. The resulting cost per unit comes to 0·0624d., inclusive of capital charges, rates, and taxes, or 0·53d. per 1,000 cb ft.

The author next deals with the costs incurred when electrical energy is developed at the central power station, with Cockerill four-cylinder gas engines of 5,000 B.H.P. (which Messrs. Richardsons and Westgarth, of Middlesbrough, are prepared to build and guarantee), coupled to fly-wheel alternators. At £13 per kilowatt, inclusive, the generating plant costs £357,000; switchboards, piping, cables, buildings, &c., raise the total capital outlay to £407,000. Allowing for interest on this capital, wages, stores, &c., the total cost per unit for the electrical central station is 0 298d.

Using 10,000 volts three-phase with underground cables, and taking the overall efficiency of the line, transformers and rotary converters at 82 per cent., the cables (in duplicate) to each sub-station are estimated, from figures supplied by Messrs. Glover, to cost £11,000.

Adding the cost of generating the lost units, the total line costs amount to 0·089d. per unit.

The cost of the rotary and stationary transforming plant in each sub-station is estimated at £26,900, which, with the buildings and accessories, makes a total of £32,900. Adding to capital charges, the cost of attendance, rates, and taxes, &c., the cost per unit for the sub-stations is 0 078d. Allowing finally 0·020d. per unit for promotion and insurance expenses, the total cost is 0·485d. per unit, a figure much below that of any large station at present distributing current for three miles.

Turning to the second scheme, the author points out the units of 1,000 B.H.P. could be used in the sub-stations, thus ensuring greater reliability. Gas compressors taking 400 B.H.P. will be required at the producer gas works, and steam must be raised for working the producers (omitted from the first scheme, as the necessary steam could be raised from the heat of the exhaust gases), increasing the cost of production by 0·0056d. per unit.

At an initial pressure of 1½ atmospheres, the diameter of the gas main—a single steel pipe—to carry 420,000 cb. ft. of gas per hour (equivalent to 6,000 B.H.P. at 70 cb. ft. per B.H.P.-hour) is 1¼ ft., and the cost is £5,000 for three miles, inclusive of laying; the capital charges, &c., on this outlay represent 0·01d. per unit for the main.

The capital charges and running costs of the compressors add 0·0037d. per unit.

The cost of the generating plant in each sub-station is estimated at £74,200, to which must be added £7,800 for switch gear, piping, &c, and £6,000 for the building. The total cost per unit for the sub-stations, including capital charges, wages, stores, &c., amounts to 0·293. Adding 0·020d. per unit as before, the total cost per unit with gas distribution to sub-stations amounts to 0·396d., as compared with 0·485d. per unit with electrical transmission.

The advantage, therefore, lies with the former.

Deducting the items common to both systems, aggregating 0·270d. per unit, the author shows that the actual transmission costs are respectively 0·126d. and 0·215d., gas transmission costing not much more than half as much as electrical transmission with underground cables. The case for gas might be further improved by transmitting gas for heating purposes through the same mains.

Pembroke (Dublin) Lighting.—The sub-committee appointed to consider the extension of the electric lighting undertaking, as laid out in Mr. Hammond's report, has recommended the Council to adopt the scheme, but that the loan to be applied for should be £25,000 and not £23,500 as recommended in the report.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Radium: A Guess.

A great many members of the learned societies are quite disposed to accept the English physicists' hypothesis in regard to the disintegration of the radium atom. But there are others, again, not quite so ready to swallow this without challenge. The case requires a little more searching thought, and it will probably be brought into line when the electrical aspects of the question are more fully gone into.

It was Maxwell who said that, When once the doctrine of the conservation of energy is apprehended, it furnishes to the physical inquirer a principle on which he may hang every known law relating to physical actions, and by which he may be put in the way to discover the relations of such actions in *new branches of science*.

Well, radium and its properties, we will say, is a new branch of science. But are we, then, to totally abandon the doctrine of the conservation of energy because we cannot immediately apply it to the radium phenomena?

We express energy as stuff moving at certain rates of velocity in time, but the only thing that exists in *fact* is the stuff itself, and this I call energy.

I observe that M. Curie has recently applied the term *aggregation* to the change in configuration accompanying the emission of energy from the radium salt, and this appears to be much more enlightening than the expression *disintegration, per se*. Because, for example, how can any system of matter go on giving out energy, if it is increasing in dimensions itself, or acquiring a form more and more capable of absorbing energy? How can a system expand and contract at the same time? How can any two particles of matter splitting up into three particles give *out* energy? It may rush in. I can understand the reverse order—the three going into two, and even imagine *a bit* being carried away where the explosion is very rapid, like quick-burning powder carrying away the chase or muzzle of a gun or blowing out the block.

But by the disintegration notion we seem to have it one-sided, without the *equivalent in aggregation*—as if the actions were all external, or actions without reactions, or emptying without voids. Or, to be a complete philistine, as if steam could move forward a piston without itself condensing or aggregating, an old story of mine. And where a thing aggregates, the common knowledge teaches us it decreases in superficies, and where it disaggregates it increases; and looking at these things as capacities, we assume that where the energy of a body, expressed electrically, or otherwise, is condensed, its potential or pressure goes up, and *vice versâ*. So that if the matter of radium condense, it should have a positive charge relative to the body or bodies shot off. But these shot-off bodies may again split up or condense, and so alter their charge sign.

J. C. R.

Shift Engineers are Cheap.

Re advertisement this week for shift engineer, tramways station, South Wales, at £50 per annum = 19s. 2·827d. per week to commence, and his qualifications again, as usual, to be immense, *viâ* previous station experience, also technical and electrical workshop experience. What is required is one of those gentlemen's sons who have not the moral courage to demand a reasonable salary for their services. I think the salary decidedly unreasonable, and I am not surprised at the advertisers not letting the applicants know who they are; it is simply disgraceful.

Disgusted.

Electricity in Mines.

With reference to your leaderette and your article referring to the report of the recent Home Office inquiry on this question in your last issue, most engineers who are intimately acquainted with the technicalities and conditions of colliery working, will scarcely agree with your contention that induction motors should have been insisted upon for

colliery purposes, but will rather consider that the committee acted wisely in leaving the selection of what type of machinery to adopt, to the engineers who are to be responsible for its installation and working. It is not always possible—for instance, in the case of coal cutting in thin seams—that induction motors can be used, and colliery owners do not, as a rule, make such huge profits that they can afford to neglect the consideration of first cost, which would probably be greater for three-phase than for continuous-current plant.

The colliery manager is hedged all around with quite enough rules and regulations, without having forced upon him what type of machinery he must adopt if he wishes to install electricity. No one is more keenly alive to his responsibilities, or more assiduous in carrying out his duties, than the colliery manager, and in all fairness he should be allowed some liberty of opinion.

It is also to be noticed that the majority of accidents that have occurred due to electricity in mines, have been traced to cables and connections, and so far as the writer is aware, no accident has occurred through sparking at the commutator of a motor, though, of course, this fact is not intended by the writer as an argument in favour of continuous current, but the adoption of three-phase in place of continuous current; would not in any way reduce—but rather add to—the risk of accident in this respect. If electricity in mines is to be installed only under vexatious rules and regulations, there is no question but that colliery managers—who are not at all particularly enamoured of electricity—will turn their attention to compressed air, which is underestimated as a competitor by electrical people, and in spite of its lower efficiency will adopt it in preference, and compressed air has *some* advantages over electricity in mines.

T. Campbell Futers.

I am very pleased to see in your correspondence of the 26th that there are other colliery electrical plants which are successful.

Now, in respect to the training of drivers in the management of coal-cutters, we owe our success:—First, to time and patience, and to the careful supervision and tuition of our drivers to familiarise them with all the electrical and mechanical parts of their machines, because I think that the driver of a coal-cutter should as fully understand his machine as an engine-driver should the steam engine. Secondly—To keeping the electrical motors clean. This is a rule which, with other rules I have drawn up, is strictly enforced by the management. The tuition and success of our drivers in stone-cutting is due to our assistant manager, Mr. Frank Eckersley, who has studied this branch of the trade, and, I may say, is an expert in matters relating to coal-cutting by machinery. He has made several great improvements in the cutters we are now using, and this fact will be fully understood when I say that we can get through more work at present using from 20 to 30 amperes than we could at one time by using a current of 40 amperes, although our machines were at the time in excellent condition.

This will show that coal-cutting machines will cut and do their work well if properly handled. Mr. Frank Eckersley is prepared to advise any less successful colliery manager to the best of his ability. Although we are not makers of coal-cutting machines, we buy them, install them, and make them work. Practice makes perfect. Our motto is—If at first you don't succeed, try, try again. But so much has been said against the coal-cutter, and the electric coal-cutter in particular, that we think it time something should be said in its favour. If it did not deserve a good name we should be the last to give it one. It has come to my knowledge lately that some coal-cutters have 70-ampere and larger fuses in circuit when they should have 48, and then it is said electric motors are no good for coal-cutting. The armatures are always burning out. No wonder! We might just as well tie down the safety valve of a boiler; do our very best to burst it, and, after we had done so, say the boiler was no good. At our colliery we like, if possible, to keep our machines under their working limit, and if by accident a sudden heavy load comes on the machine which runs it up to its working limit, and cannot always be guarded against, well, we have a suitable fuse in circuit to guard against damage to the motor. In respect to the wearing of the commutators of our motors, I am pleased to say that they give us very little trouble, because they are well looked after, kept free from oil and dirt, which causes sparking, and, by keeping the tension on the brushes as light as possible, we get on very well. Now, in reference to the letter of my friend, Mr. F. J. Milne, *re* electric winding, I quite agree with him that when the boilers are situated close to the winding engines it would not always be economical to use electricity; but in our case, after very careful consideration, the management has come to the conclusion that electric winding in place of steam will be a great saving. The electric winding machinery we have here will not be fixed on the surface. Leaving the surface, we go down a shaft a distance of 450 yards, and upon reaching the bottom we walk about 50 yards, which brings us to another winding engine house, and in it there are a pair of winding engines to wind coal out of another seam a distance of about 250 yards. The economy of electric winding will be fully understood when I say that the steam pipes, after leaving the low-pressure boilers, have to travel a distance of about 520 yards before they reach the engines. Taking into consideration the weight of pipes in the shaft, loss by condensation, trouble with joints blowing in the shaft, and minor repairs, we are certain that electric winding will be a great saving to us; and our mechanical engineer, Mr. Mansfield Richardson, has every faith in the undertaking. I don't see, even if coals and steam are cheap at a colliery, why a colliery company should burn two tons of coal if one will do. There are a few more collieries situated somewhat similarly to us. Some have had electric winding installed, and one I know has been running about two years with very little trouble, and the cost of repairs has been insignificant. I am sorry to note two fatal accidents at collieries in Yorkshire. At one well-known colliery where electrical coal-cutters are installed a workman met his death through electric shock; at another colliery several persons were killed through another cause. Taking into consideration the number of colliery electrical plants now working, the death rate through electricity is very low; and it is the duty of us who are in charge of electrical plants, with the assistance of colliery managers, &c., to make accidents from this cause few and far between. Accidents will happen, but we must guard against locking the stable door after the horse has gone. By doing this, I hope we shall be able to inspire confidence into the minds of those who are not users of electricity. In conclusion, I thank Mr. F. J. Milne for his good opinion of me, and I congratulate him on the efficiency and satisfactory working of his system.

John Bentham,
Electrical Engineer.

New Sharlston Collieries,
near Normanton.

The Coal Supply.

With reference to your suggestion of placing an additional tax of 1s. a ton on exported coal in order to curtail its outgoing, I am afraid you would not attain your object by such a small tax; if you put a tax of 5s. per ton on exported coal, you would probably achieve your object. A 1s. per ton tax would not stop the export of the steam coals in the slightest degree whatever. When the present tax of 1s. per ton was imposed on exported coal, it was said that it would ruin the coal trade, but experience has proved otherwise.

The export of coal from South Wales is still increasing by leaps and bounds each year, Cardiff, Penarth and Barry vieing with each other to turn out record quantities, which are measured in millions of tons. The colliers' wages are still at a good level, and the price of coal generally keeps good. We in Cardiff, where we are only distant about 10 to 12 miles from the colliers' stall where the house coal is got, have to pay 1s. to 1s. 4d. per cwt. to the carts for it. But, there, to get a tax of 5s. per ton on coal would be a most difficult thing to achieve, as so very many interests are involved in the matter. Limitation of output for export is, as far as I can see, a thing of the distant future, when there will be no more coal to be had to be dumped into the ships. Every colliery seems bent upon getting its maximum output day after day.

As regards the duration of our coal supply which you put at 200 years, I should say as regards South Wales, that in another 50 years the best veins of coal will have been worked out, that is, at their present rate of output. The chief seam of steam coal that has been worked up to the present in the Rhondda and Merthyr Valleys is what is locally called the 4-ft. seam. When I tell you that in most of these collieries the face of the coal (that is, the colliers' stalls) are distant more than a mile from the bottom of the pits, and that each colliery's leased ground is generally not five miles in diameter, you can readily judge if this seam of 4-ft. coal is going to last many years. This 4-ft. coal is a very hard, tough coal, but much further down, under this seam of coal lies another, called the 6-ft. seam; the coal from this is a most beautiful coal, gives a fierce, white heat with little smoke and little ash, but unfortunately it is very brittle and friable, and will not withstand much knocking about. The two coals are usually tipped together, mixed as it were. As yet only a few collieries are working this 6-ft. seam, notably the Cymmer, Great Western, &c. As showing how the coal seams are already giving out, I may say that the 2 ft. 9 in. house coal seam is for the most part worked out in the Rhondda Valley. This coal is mined generally for making into blast furnace coke, which is the best produced so far. Ten years hence there is not likely to be much more of this coal left. Since Christmas we have had three collieries shut up, two steam coal at Hirwain, and the Tynewydd house coal colliery, Rhondda. There is a great house famine going on, but builders won't build, as what with the subsidences of the ground and the possible closing down of the local colliery in a few years they say it won't pay. Hence the inhabitants live in a much packed condition.

We in Cardiff are to open a new dock shortly, which will be equipped with tipping appliances to accommodate 20-ton trucks if necessary, to get rid of the coal in a quicker manner.

To me, the only possible alternative to this great exportation of coal for maritime purposes is to devise a system of electric radiation that would be capable of raising steam up to 200 lbs. sq. in. pressure. That should not be impossible. The present day carbon filament glow lamp is neither designed to give the maximum amount of light nor the maximum of heat, therefore who can say that it must always be impossible to invent a lamp capable of radiating a maximum of heat something after the electric light baths. Given a good lamp among suitable reflectors and placed in an enclosed compartment strongly charged with carbonic acid gas, there is no reason why it cannot be reduced to a workable basis. There certainly is a great field for such an apparatus.

Geo. H. Smith.

Cardiff, *February 29th*, 1904.

[In his last paragraph our correspondent gets beyond his depth.—Eds. E.R.]

Small Gas Engines v. Electric Motors.

As your article on the above subject raises points of considerable importance, I shall be pleased if you can find room for the following remarks.

There must surely be some mistake, either in the estimation of the power of the engine, or in the quantity of gas paid for, as with a mechanical efficiency of 76 per cent. it will take 4·4 I.H.P. to run the engine empty, and at 20 cb. ft. per I.H.P.-hour (a fair working figure) we should consume 54,912 cb. ft. for the quarter, costing at 2s. 6d. per 1,000 cb. ft., say, £6 17s., and this for no useful work at all.

You have made no allowance at all for ignition tubes; these would average at least 7s. 6d. per quarter, and it would be valuable information to know, where you can obtain gas engine cylinder oil at 1s. a gallon, in such quantities as a joiner is likely to buy.

With regard to the electrical running of the shop, you appear to consider that the machines will be standing the major portion of their time; now, an average joiner's shop using a motor of 10 H.P. would have circular saw bench, planing and thicknessing machine, grindstones, vertical moulding spindle, and probably a lathe, and unless the shop was installed for the benefit of the motor, one or other of these would be nearly always at work. If we accept your estimate of the running time, is there any public authority who would supply current to a 10-H.P. motor at 1·5d. per unit, for a quarterly consumption of 680 units, or only about 3 per cent. of the possible?

Had you suggested a separate motor for each machine, you would have made a better case for the electrical drive.

An instance of an 8-B.H.P. gas engine driving a small engineer's shop is here given—gas at 2s. 3d. per 1,000 cb. ft.; the engine had to run 53 hours per week, and cost 13s. for gas.

Accepting your figure of 30 cb. ft. per B.H.P.-hour, we have for the quarter 2,476 B.H.P.-hours, at a cost of—

For gas	£8	9	0
Cylinder oil at 2s. a gallon	0	19	6
Waste and bearing oil	0	10	0
Ignition tubes	0	7	6
Attendance, repairs and water (your figures)...	2	16	6
	£13	2	6

= say, 1·27d. per B.H.P.-hour.

Say, 6-H.P. motor for same works—

Current at 1·32d. per B.H.P.-hour, for 2,476 B.H.P.-hours = say	£13	12	4
Sundries, as per your figures	0	15	6
	£14	7	10

= say, nearly 1·4d. per B.H.P.-hour.

As you say, to beat 0·9d. per B.H.P.-hour (in motive power of this size) is difficult.

H. Mensforth.

London, *February 29th*, 1904.

Referring to your article making this comparison, the writer has taken very extreme and unusual figures for the consumption of gas. Anything like a 14-B.H.P. modern engine, when working at 7 H.P., would only take 18 cb. ft. per B.H.P.-hour at that load, or 15 cb. ft. per B.H.P.-hour at full load. Then, again, the writer's figure for oil consumption, 1 quart per day, is absurd. For a small engine of that kind, a consumption of about 2 pints per week should be ample. A gas engine does not require daily cleaning; about half an hour per week should be sufficient. Such an engine simply requires to be stopped and started, and the lubricators filled. No doubt electric motors have many advantages; so have gas engines. There is much to be said on both sides, and it is only just that the figures for both sides should be correctly given. On the other hand, many gasworks are now supplying gas for motive power purposes at prices varying from 1s. 3d. to 2s., and a good modern engine with its own private gas plant and electric generator can produce a B.T.U. of electricity for about ¼th of a penny.

G. A. Hibbard.

Manchester, *March 1st*, 1904.

Municipal Appointments.

A few weeks since there was some correspondence in your columns *re* the methods in which these appointments are frequently made.

Recently a U.D.C. advertised for a resident engineer, and applications were returnable not later than the 22nd ult. This morning I received a notice (doubtless in company with other candidates) informing me that the appointment was made on the 27th ult. The gentleman appointed was the consulting engineer's assistant at another station.

The appointment may have been a very proper one, but it would be interesting to know whether any other candidates were communicated with or interviewed, in view of the short time which elapsed before the appointment was made.

If the whole thing is a "put up job," as appears to be the case, why did the Council in question spend the ratepayers' money in advertising and having forms of application printed?

There is no objection whatever to appointing the consulting engineer's assistant, but, I submit, if that is the Council's intention, engineers should not be put to the trouble and expense of applying for a position which is virtually filled before the advertisement is issued.

Candidate.

March 1st, 1904.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

The annual meeting of the members of this young, but very energetic, association of electrical business men, was held on Tuesday afternoon at the Hotel Cecil, Mr. Walter Davenport, the secretary, presiding. The report of the committee, which in future years will be circulated to members prior to the meeting, showed that much important work has been done in the interests of electrical manufacturers, fully justifying the existence of the Association. At the end of 1903 the membership was 57, the number of new names added during the year being 29. The negotiations with the China Furniture Manufacturers' Association had required a great deal of attention, and the result was that so far as concerned the Electrical Manufacturers, the China Association was stated to be now non-existent. "The few firms who formerly dictated in that Association are now eagerly competing with each other to the benefit of the members of our Association, who are no longer restricted by the various clauses which were in force under the old arrangement." The Association "reference book" had not been quite so successful as was desired, because members had failed to avail themselves of it to the full, and, in the course of discussion, members were urged to increase the value of the assistance and protection obtainable from this source by sending more inquiries and complaints respecting firms, to the secretary. The negotiations with a view to bringing the Plant and Cable Associations into line with the Manufacturers' and Contractors' Associations had proved abortive. The Manufacturers' and Contractors' had, however, formed a joint committee, consisting of four members of each body, with Mr. Davenport as secretary, to consider any questions or disputes which might arise between members of the two Associations. The finances of the Manufacturers' Association are satisfactory, there being a balance of £84 in hand. The committee pointed out a way in which united action amongst the members would be most advantageous, thus:—"In the event of a liquidation or bankruptcy where it may be felt that everything is not as it ought to be, any member who is a creditor and happens to have special information which might throw light on the state of affairs, could, by communicating with the secretary, get into touch with other members who are interested, and so, perhaps, by united action, better terms might be arranged than would be forthcoming should the liquidation or bankruptcy pursue its course unopposed." The report was adopted on the motion of Mr. Davenport, seconded by Mr. Max Byng, and after some discussion it was adopted. Mr. Justus Eck asked whether everything had worked satisfactorily so far as the joint agreement was concerned. Mr. Davenport said, in reply, that it was mutually agreed that in order to become a member of the Manufacturers' Association a firm must not be contractors, and in order to be a member of the Contractors' Association it must not be a manufacturer. Undesirable firms were in existence, and the difficulty was to find a way for such firms to be one thing or the other. This matter was to come before the joint committee at its next meeting. A member asked whether there was any way of dealing with contractors who did not meet their monetary obligations. Did they cease to be members of the Contractors' Association? In some cases they had used their connection with the Association as a recommendation to get credit. Mr. Davenport said that it would constitute a grievance against them, and would have to be considered. They could take means to get rid of undesirable members. The first thing for the members of the Manufacturers to do was to "Black List" such a contractor. Mr. Lundberg moved that it be a recommendation to the Committee to accumulate the entrance fees, together with any surplus funds, and invest them as a special fund, the interest thereon to be applied to revenue account. There was a feeling with some that there was no need for such an association to accumulate funds, rather should the entrance fee (now raised to £5 5s.) be reduced. The resolution was, however, adopted, and the financial statement was also approved, Messrs Birnbaum and McLeod being re-elected auditors. The retiring members of the committee were re-elected and the entire committee was thanked for its management of affairs during the year. A special vote of thanks was accorded to the secretary, Mr. Davenport; and, on the motion of Messrs. Northcote and Byng, it was resolved to set apart from the funds a sum of 20 guineas, for the purpose of presenting Mr. Davenport with a token of their appreciation of the services rendered by him. It is proposed to hold an annual dinner of the Association shortly.

LEGAL.

Metropolitan Electric Supply Co., Ltd., *v.* Marylebone Borough Council.

Mr. Justice Buckley, in the Chancery Division on Friday last, had before him a motion in which the defendants asked for an extension of time in which to complete the purchase of that part of the plaintiffs' undertaking which is situated in Marylebone.

Mr. Buckmaster, K.C., and Mr. Clayton appeared for the Borough Council, and Mr. Cripps, K.C., Mr. Astbury, K.C., and Mr. Sergeant for the company.

At the conclusion of the arguments, his Lordship said that he wished it was in his power, judicially, to discriminate between the ratepayers and the Borough Council. For the ratepayers, so far as it was proper for him to express sympathy at all, he had great sympathy. They found themselves saddled with an enormous obligation, through no fault of their own, and, so far as it lay in his power to relieve them, he desired to do so. For the Borough Council he felt no sympathy at all. They were, no doubt, persons who were doing their best as they thought, but were minded to enter into an obligation, the burden of which fell not on them, but upon others. Judicially, he could only consider the borough governed by the Council, but paying through the ratepayers. The point he had to determine was a very commonplace one as between the borough and the vendors of the company as to what were fair terms upon which he was to allow the purchasers not to perform the present obligation, but to have time given them in order that they might meet the obligations which they could not at present discharge. The judgment named December as the date at which the completion of the contract should be carried out; but the borough was not in a position to complete, and on December 11th an application was made to him for an extension of time. He gave the extension until February 29th on certain terms. There was a sum of £67,250, and further sums which were not exactly ascertained, due to the company in respect of capital expenditure. The terms he imposed were that £60,000 out of the £67,250 should be paid within a certain time, and then the time for completion should be extended until February 29th. The borough had taken steps in the hope of expectation of putting itself in a position to borrow the money which it had not got in order to complete the purchase, and had introduced a Bill into Parliament, and sufficient time was necessary in order to carry that Bill to a successful or unsuccessful issue. Everybody hoped that it would be successful. Failing that, they had not got the money, and they asked for a further extension of time until August 31st. Their counsel at the Bar had modified that by asking him to simply extend it until April 30th. His Lordship had suggested that it would be a useful form of order to grant an extension until April, and that there should be provision that in the event of the payment of certain sums before April 30th, then there might be a further extension until May 31st, and so on month by month until August arrived, the intention of that form of order being that such a sum should be named as a price of further extension, so that the purchasers might keep the vendors out of cash advances. However, the defendants' counsel preferred not to take an order in that form. His Lordship thought there ought to be an extension, because it was nobody's interest that the matter should be brought to a stop before the purchasers were able to pay. The question was, What were the fair terms on which the extension might be granted? The general principle on which he was going to proceed, was that there was an undertaking in respect of which further capital expenditure was necessary under the orders of August 7th and December 11th, when provision was made for the completion in the district of a conversion from high tension to low tension. That was going on, and it would go on, and more remained to be done, and money must be found for doing it. Therefore there was further capital expenditure necessary for this purpose, besides which new connections must be made. The position was that the vendors, through no fault of their own, but wholly through the default of the purchasers, were left in control of an undertaking which in equity was no longer theirs, but the purchasers', and the vendors were bound to go on spending money. The purchasers said it was exceedingly inconvenient to them to find the money, and threw it on the vendors. The further moneys which were wanted ought to be borne by the purchasers, through whose default the contract of purchase was not completed, and the fair principle to apply was that the purchaser and not the vendors should find the further cash which was wanted in order to do that which was necessary to keep alive the undertaking which the purchasers had agreed to buy. The question, therefore, was what figure he was to allow the vendors. He was desirous not to press hard upon the ratepayers, who were the unfortunate victims in this matter, and he wished to name as low a figure as possible. He would name a figure, but if the plaintiffs would name a lower figure and would accept it, it must be taken to be a great concession by them. If a further application were made to extend time in April, he should regard it on the same principle as he was regarding the matter then, and if the defendants wanted further time they must find the current expenditure so as to keep the plaintiffs out of cash advances, and he should not expect to hear that there was anything oppressive on the part of the plaintiffs in saying that if the defendants wanted further extension they must find some money. Now there was £27,904 claimed by the plaintiffs as capital expenditure. Defendants said that sum was not vouched at present. Then he had to add the March and April sums, and the capital expenditure account would then amount to roughly £33,000. The sum which he named which ought to be fixed as a condition of the extension being granted was £20,000, but he would invite the plaintiffs to say whether they would not accept £15,000.

Mr. Cripps said his clients would certainly accept £15,000.

His Lordship: I am very glad to hear it. It is very good of your clients to assent to my suggestion. I think the ratepayers much to be pitied. I will therefore extend the time until April 30th, imposing as a term that the defendants pay to the plaintiffs on or before March 31st, the £15,000.

Order accordingly.

Marshall *v.* Lock.

[*Engineering Apprentices.*]

In the King's Bench Division on Thursday, Mr. Justice Darling and a common jury heard an action brought by Mr. Alfred William Marshall against Mr. John Henry Lock, of 78, Temple Chambers,

Bouverie Street, E.C., to recover £70 premium and other moneys paid to the defendant for binding plaintiff's son as apprentice.

Mr. McCall, K.C., Mr. Rose Innes, and Mr. Saunders appeared for the plaintiff, and Mr. S. Lynch and Mr. Bray for the defendant.

Mr. Saunders said that the grounds upon which the action was brought were that the defendant had fraudulently held himself out and by verbal and written misstatements had represented himself to be capable of taking plaintiff's son as an apprentice, when, in fact, he was not in a position to do so. In August, 1902, plaintiff saw the following advertisement in a number of papers:—

Electrical Engineering and Motor and General Engineers.—Well-known London works have a vacancy for pupil; hours, 9 till 6; wages, 10s. weekly after one year's training; permanency; premium, 35 guineas. Address, Box B, Taylor's, 154, Fleet Street, E.C.

Plaintiff communicated with the defendant, and received a type-written letter, which had the printed heading—

Bouverie Street Engineering Works, Mechanical and Electrical Engineers' J. H. Lock, engineer. Established 1886. Maker of steam, gas and oil engines' dynamos, motors, &c. J. H. Lock's exhibits at various industrial exhibitions have received high commendation and praise.

The letter also contained a number of unsigned testimonials and reprints from newspapers. Plaintiff then had an interview with the defendant, who told him he carried on a large business, and alleged that after a year's training plaintiff's son would be able to command a good position. He also said he was so full of orders that he had difficulty in executing them. A premium of 40 guineas was arranged, and plaintiff paid a further £40, which the defendant was to return in pocket money to the son. Plaintiff's son had no sooner arrived than he came to the conclusion that the whole thing was nothing more or less than a swindle. The so-called works consisted of a lumber room, a drawing office, a patent shop, and an engine room which contained one motor-car and a disused engine. There was no qualified man at the works except the defendant. The only sign of any work being done was that the pupils wore engineering caps. Plaintiff's son remained for three months, and was appointed head of the drawing department, with the not unnatural result that the junior pupils entirely refused to obey his orders. Trouble resulted, and plaintiff's son was told he had better go away for a day or two. He went, and did not return. £12 of the pocket money had been paid to plaintiff's son.

The Plaintiff having given corroborative evidence, the jury went and inspected the defendant's premises.

A great deal of evidence was called, and the hearing was resumed on the following day.

Mr. Bray, in opening the defence, denied the alleged representations with regard to orders. There were no orders. It was not a works in the ordinary meaning of the word; it was a practical school of engineering, and the most practical that anyone could possibly send a lad to. They had heard the story of the idle 'prentices; they would now hear the story of the industrious ones. The defendant was an engineer of large technical and professional experience. He took no orders, but gave practical instruction to all his pupils, and they all did practical work.

Mr. J. H. Lock, the defendant, said he had 27 years' experience as an engineer. He was apprenticed at the North London Railway Locomotive Works, and paid a premium of 150 guineas. He then worked in the Lancashire depôt of the L. and N.W. Railway Co., and afterwards for a large firm of Government contractors. He left that to become superintendent of the Crystal Palace Co.'s School of Engineering, and resigned when he took out a patent for a boiler he had invented. When he started his present business he took in general work, but thinking it would be more beneficial to his pupils if he taught them the construction of engines from start to finish he ceased to accept orders. Twelve months ago last Christmas he took over the whole five floors of his present premises, and had constructed about £400 worth of compound engines. Since young Marshall came to him he had built two large compound engines, four smaller ones, two dynamos, and an electrical motor. The pupils were employed making engines, one of which was then at the court for the jury to see. He had, of course, to teach these young men by degrees. It was necessary, first of all, to teach them drawing and how to use their tools. He had £1,500 worth of plant and everything necessary for the making of motor engines. In order to have a record of what the pupils knew, he gave them an examination book of 100 questions to answer relating to engine work. The pupil would have the option either of going into the drawing office or one of the workshops. Plaintiff said his son had been at Vickers, Sons & Maxim's, and he wanted to get him something different to an apprenticeship, and witness agreed to accept him as an assistant. Young Marshall was an excellent draughtsman, but was idle, and the moment he was given work to do he went on strike. Witness was consulting engineer to a mining company at a salary of £500.

Cross-examined: He employed a paid staff of eight men and now had some 30 pupils.

Do you think it fair to describe this academy in Bouverie Street as a well known London firm of electrical engineers?

I was agent for introducing pupils to large works elsewhere. It was a combined advertisement. In advertising you must draw a strong advertisement.

Oh, that is the principle! I agree it is a strong advertisement.

Replying to further questions, defendant said he had trained 300 apprentices who had gone into situations, and were doing well. They had learned the business of a general and electrical engineer with him. He had received £10,000 in fees from his pupils, and had never had a complaint until Marshall came, nor had he had one since. He received 150 answers a week to his advertisement, which had been running for 10 years. His works were the largest in the city, having a flooring space of 8,000 sq. ft.

A number of pupils gave evidence.

The jury found for the plaintiff for the amount claimed, and judgment was entered accordingly with costs.

Mr. Bray asked for a stay of execution on the ground that the verdict was against the weight of evidence.

His Lordship: Yes, on the usual terms that you pay the money into Court.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Feb. 24th, 1903.	
Adelaide	Value £35
Alexandria	85
Amsterdam	60
Auckland	92
Bangkok	59
Bombay	150
Boulogne	54
Buenos Ayres	81
,, Teleg. mat.	209
Calcutta	1,386
Canada, *via* United States	65
Cape Town	693
Colombo	225
Durban	1,817
East London	573
Fremantle	380
,, Teleg. wire	454
Gibraltar	28
,, Teleg. mat.	11
Gisbourne	70
Hamburg. Teleg. cable	1,030
Hong Kong	16
Madras	303
Melbourne	598
Mersina	10
Perth	132
Port Elizabeth	243
,, Teleph. mat.	159
Rio de Janeiro	29
Rotterdam	150
Shanghai	540
Singapore	111
Sydney	745
Tientsin	242
Wellington	122
,, Telephones	925
Total	£11,891

Week ending Feb. 23rd, 1904.	
Adelaide	Value £51
Alexandria	220
,, 78 loads teleg. poles	—
Amsterdam	82
Auckland	65
Bilbao	17
Bombay	59
Brisbane	59
Buenos Ayres	109
Calcutta	546
,, Teleg. mat.	1,184
Cape Town	288
,, Teleg. mat.	294
Colombo	56
Coronel. Steam elec. mchnry.	279
Delagoa Bay. Teleg. mat.	6,827
Durban	1,008
,, Teleg. mat.	1,028
East London	1,756
,, Teleg. mat.	1,338
Gibraltar	989
Hobart	550
Hong Kong	1,037
Lisbon	20
Lyttelton	35
Melbourne	55
Mersina. Teleg. mat.	16
Ostend	20
Paris	64
Penang	102
Perth	35
Port Elizabeth	53
Reval	127
Rio Grande	29
St. Petersburg. Teleg. cable	1,312
Santos	19
Shanghai	526
Singapore	118
Sydney	694
,, Teleg. mat.	2,450
Tokio	28
Wellington. Teleph. cable	2,121
Yokohama	311
Total	£25,916

Foreign Goods Transhipped.

Paris. Elec. mat.	Value £26
Total	£26

Buenos Ayres. Elec. mat.	Value £168
Durban. Elec. mchnry.	107
Total	£275

Electrical Wares Exported.

Week ending Mar. 3rd, 1903.	
Adelade	Value £350
Alexandria	81
Amsterdam	110
Auckland	46
Bombay	433
Buenos Ayres. Teleg. mat.	65
,, Teleph. mat.	435
Calcutta	386
Canada, *via* United States	11
Cape Town	28
Channel Islands	15
Colombo	10
,, Teleg. mat.	124
Durban	355
East London	368
Genoa	280
Gothenburg	11
Invergargill	53
Labuan	254
Lyttelton	944
Malta	11
Melbourne	412
Nagasaki	203
Paris	880
Perth	308
Port Elizabeth	3,282
Santander	13
Shanghai	330
Smyrna	30
Sydney	502
Wellington	63
Yokohama	439
Total	£10,822

Week ending Mar. 1st, 1904	
Alexandria	Value £86
Amsterdam	65
Antwerp. Elec. fuses	222
Bangkok	109
Bombay	18
Brisbane	29
Buenos Ayres	100
Calcutta	1,047
Cape Town	1,806
,, Elec. Instruments	139
Channel Islands	13
Coatzacoalcos	37
Colombo	118
,, Teleg. mat.	30
Durban	2,624
,, Teleg. mat.	947
East London	934
,, Teleg. cable	482
Halifax	55
Hamburg	321
,, Teleph. mat.	313
Hong Kong	75
Lyttelton	258
Madeira	24
Malta	39
Melbourne	249
N. Atlantic. Sbmne. Teleg. Cb.	10,264
Port Elizabeth	27
Port Said	20
Rotterdam. Teleg. cable	257
Shanghai	229
Singapore	768
Sulina	25
Sydney	751
,, Teleg. mat.	59
Wellington	124
Yokohama	64
Total	£22,728

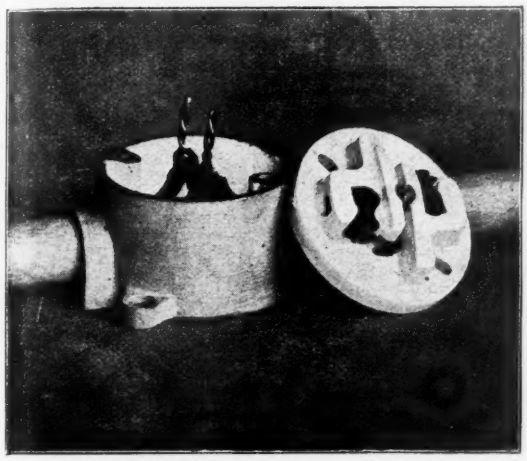
Foreign Goods Transhipped.

Fremantle. Elec. lamps	Value £69
Gothenburg. Elec. apparatus	55
Port Elizabeth. Elec. mat.	290
Trinidad. Teleph mat.	22
Total	£436

Durban. Elec. light mat.	Value £19

Adhesive Tape, and Asbestos.—We have received from the India-Rubber Manufacturing Co., Ltd., of Deptford, samples of their Farridine (Regd.), Adhesive Tape and Tenacetine (Regd.) Asbestos. The former is guaranteed to maintain its sticking capacity for years, and to be an effective insulator under any conditions. It is supplied in standard size rolls. The Tenacetine Asbestos is claimed to be unrivalled as a jointing material, as it is claimed to resist absolutely high steam pressure, superheated steam, acids, ammonia, alkaline and hot sugar solutions, oil, alcohol, dry heat, &c., and is specially suited for joints subject to vibration.

A New Pattern Ceiling Rose.—Messrs. Dorman and Smith, of Ordsal Electrical Works, Salford, have introduced a new ceiling rose, with the object of cheapening the cost of wiring when conduits are used. The porcelain rose is in one piece only, the terminals being sunk into the porcelain on the inside, so that there is no necessity for a separate cover. The terminals are large and



New Pattern Ceiling Rose.

substantial, and are suitable for looping through for the main wires to be carried on to the next ceiling box without break. The pendant flexible is first attached to the terminals through a deep V-shaped cord-gripping formation in the ceiling rose. The rose, with its pendant flexible, is then attached to the jointing-box by two screws, as shown in the accompanying illustration. The makers stock iron jointing-boxes with 2 ways and 4 ways, screwed for ½-in. gas thread, or ⅝-in. or ¾-in. Simplex.

Motor-Car Show.—The Motor-Car Exhibition, which is to be opened at the Agricultural Hall, London, on March 19th, will be the ninth of the series inaugurated by Messrs. Cordingley & Co. at the Agricultural Hall, and, according to what we hear, will be a very fine display. It will be especially strong in motor vehicles for municipal and public utility.

A New Steam Turbine.—A powerful syndicate has just been formed in Berlin to put on the market a new steam turbine known as the "Zoelly," for which many advantages are claimed. The concerns comprised in the syndicate are:—Messrs. Siemens-Schuckert, Berlin; Messrs. F. Krupp, Essen; Messrs. Escher, Wyss, & Co., Zurich; the North German Engineering Co, Bremen; the Nurembourg Engineering Co., Nurembourg; and the United Engineering Co., Augsburg.

Works Visit.—On Saturday, February 20th, a visit was paid to the works of Meldrum Bros., Ltd., at Timperley, near Manchester, by the staff and employés of Messrs. B. & S. Massey, Ltd., C. Churchill & Co., Ltd., Mr. S. N. Brayshaw, and the Altrincham Science students.

American Electrical Exports.—There was a falling off last year in the exports of electrical machinery from the United States, the returns just issued showing a total of only £1,020,900 as compared with £1,187,528 in 1902. On the other hand, the exports of electrical appliances increased from £811,910 to £950,309.

Fire Alarm Installations.—The May-Oatway Fire Appliances, Ltd., have placed the contract for wiring the premises of Messrs. J. and B. Stevenson on their system with Messrs. Carrick and Topping, and that of the premises of Messrs. Gilmour, Thomson and Co. with Messrs. Raeburn & Duncan.

"Graphic" Souvenir.—We have received an illustrated souvenir of the opening of the new *Graphic* offices by the Prince and Princess of Wales on the 18th ult. In the new building in Tallis Street there are eight printing machines, each driven by a 10-H.P. electric motor; these were set in motion by the Princess of Wales. Power is derived from the mains of two companies, and all the machinery is electrically driven. We are pleased to add that all the machinery in this large establishment is of British manufacture.

Catalogues and Lists. — Messrs. Crompton and Co., Ltd., of Chelmsford, have issued (1) a second edition of their potentiometer pamphlet, (2) a price list of testing room appliances, and (3) a brief description of their electrical pyrometer. No. 1 is a 26-page art paper pamphlet, giving some very clear diagrammatic explanations and half-tone illustrations of the potentiometer, with which our readers are already to some extent familiar; the list will be acceptable to those who want a complete description of the apparatus, and a separate leaflet of prices accompanies it. No. 2 shows in the same excellent manner reflecting galvanometers, resistance boxes, coils, and so on, and No. 3 gives some brief information respecting, and an illustration of, the Crompton pyrometer for use with steam plants.

The B.T.H. Co.'s pamphlet No. 164, just issued, describes the type "H" oil transformers.

A list of asbestos slates for roofing, ceilings, floorings, also an insulator for switchboards and bases, has been brought out by the Cape Asbestos Co., Ltd., of 8, Minories, E.C.

Mr. J. Burns, of 76, Little Britain, E.C., is circulating a new list respecting the "Delaware" vulcanised fibre for electrical insulation and other work.

Section II. of a new catalogue has come to hand from the Crypto Works, Co., Ltd., of Clerkenwell Road, E.C. It details their several types of small dynamos, motors, boosters, transformers, and so on, and gives prices and cuts thereof.

Some new pamphlets have been issued by the General Electric Co., Ltd. One describes the "Geeko" fire alarms, and gives in a concise form full particulars for installing a complete fire alarm system. The different apparatus shown includes some of the latest ideas put forward for this class of work. The automatic fire alarm is of the self-adjusting type, and is claimed to be both sensitive and practical. The apparatus was awarded the Gold Medal at the recent International Fire Exhibition at Earl's Court. The company's February progress sheet publishes the prices of the well-known "Peel" main switch, and a new type of switch which has been named the "Quadrant" marks an advance in the design of switches of the "Tumbler" pattern, and, we understand, has already met with success. Glass ware of a new design is also detailed, including the "Vein" shade.

Mr. J. S. Grover, of Brittania Works, Popham Road, N., has issued a circular relating to his patent jointing mastic, which has been supplied to various electric lighting and traction authorities in the kingdom.

Messrs. Körting Bros., Ltd., of 53, Victoria Street, S.W., recently brought out a catalogue (122 pp.) giving fully illustrated particulars of some of their appliances for steam users and manufacturers, including condensers, injectors and jet apparatus of all kinds, and pistonless steam pumps. Among many things of interest to the power station engineer we find liquid fuel apparatus. Central station men might find a study of this list worth making.

The Yorkshire Electric Power Co. has issued another pamphlet showing the advantages which local authorities can obtain by purchasing energy in bulk from power companies. Scales of charges, and a note of arrangements which other power companies have made with authorities in their areas, are given.

A pamphlet has been issued by the Standard Varnish Works, of 23, Billiter Street, E.C., and the U.S., detailing their insulating varnishes for electrical machinery.

Messrs. Nalder Bros. & Co., of Westminster, have issued a new catalogue (eighth edition) of electrical testing, engineering, mathematical, optical, and other scientific instruments. It is a fine production of some 124 pages, and the use of art paper throughout secures an excellent printing of the numerous illustrations. The arrangement of the contents is simple and straighforward, for they are tabulated with reference number, description, price, and code words in four columns across page. To enumerate the many types of instruments shown is impossible here, but in addition to various galvanometers, condensers, electrometers, batteries, shunts, needles, &c., we note that the firm is making a special feature of photometers both for indoor and street work.

Messrs. C. J. Thursfield & Co, of Birmingham, have issued a supplementary catalogue showing some new and most artistic designs of electric light fittings.

A variety of price lists have been received from the Bergmann Electrical Works, of Farringdon Avenue, E.C., particularising and giving illustrations of electric light conduits and wires, electrically-driven fans, three-phase and direct-current motors, electric lighting accessories, lift controllers, motor starters and regulators, switches and so on.

Messrs. Griffith & Biliotti, of 8, John Street, Adelphi, Strand, W.C., have sent us a price list of their S.C. type induction motors. The firm have equipped their works for the manufacture of this class of machinery, of which they make a speciality, and they have placed on the market an English-made machine, which is claimed to be of first-class quality, though low in price.

Trade Announcements.—Owing to the necessity for extended premises to deal with their increasing business, Messrs. Belliss & Morcom have removed their London office to 8, Victoria Street, S.W.

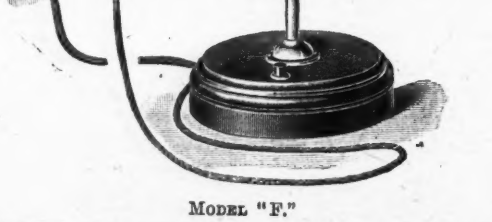
Mr. S. Dicks, who for eight years represented Messrs. G. Straus and Co., Ltd., of Upper Thames Street, has severed his connection with that firm, and has joined the Armorduct Manufacturing Co., Ltd., of Farringdon Avenue.

Electrical Plant for Sale.—Full particulars are given among our advertisements to-day of certain three-phase alternating electrical power transmission plant which is offered for sale by Mr. G. N. Dixon. The plant is in use at the Frongoch mines, near Aberystwyth, and it is to be sold without reserve on April 11th—15th. A description of the undertaking appeared in the Electrical Review Special Power number for September 12th, 1902.

The Parlyphone.—We recently had the pleasure of inspecting the new showrooms and premises of the Berliner Telephone Manufacturing Co., at 200, Upper Thames Street, E.C., under the genial guidance of the general manager, Mr. J. B. Birnbaum, whose energy is only equalled by his enthusiasm in telephonic

Model "D."

matters. One of the most interesting of the many ingenious devices in the showrooms, was the "Parlyphone" type of domestic telephone, which we have previously described, but which has undergone continuous elaboration and improvement until almost every domestic application has been brought within its scope. The



Model "F."

original Parlyphone was adapted for ringing one way only; now it is made for ringing both ways, with or without attached bell and battery, for common battery or local battery working, for table use, and for temporary extension from wall to table. Model E, with bell, ringing key, and battery combined, is completely self-contained, the only operation required for the installation of a pair being the connecting of two line wires to the two instruments. A variety of modes of coupling up the Parlyphones with ordinary bell installations has been worked out, to meet all sorts of requirements, including ringing both ways and speaking between one station and several others. The annexed figures show Model "D," with bell and key, for ringing both ways, and Model "F," for table use, with cradle, ringing key, and a buzzer concealed in the base.

We are informed that Mr. F. G. Bell, who was for many years connected with the telephone department of the General Electric Co., Ltd., has joined the senior staff of the Berliner Co. Mr. Birnbaum is a host in himself, and we do not doubt that under his able management the business will continue to expand in the future as in the past.

Ruthven-Murray Bridge-Pieces.—A bridge-piece has been recently designed by Mr. E. T. Ruthven-Murray for supporting cables laid in troughs on the solid system, and the patent rights have been taken up by the British Insulated and Helsby Cables, Ltd. We understand that, during the first six weeks after taking them up, the firm obtained permission to use nearly 70,000 of these bridge-pieces. The principal advantages claimed are that the cable can now be kept automatically central in the trough, whether constructed of iron, earthenware, wood, or other material; and there is no obstruction below the cable to the free flow of the hot bitumen, pitch, or other filling material employed, whereas wood and stoneware bridge-pieces have always presented serious difficulties in the successful laying of cables on the solid system. We have received a sample bridge-piece, and the stiffness which is obtained by the arching of the bottom and sides is especially noteworthy; this stiffness is required chiefly when the bridge-piece is used for wooden troughing. It is claimed that the new bridge-pieces are not more expensive than wooden ones. Our only objection to the device is that it places the lead sheathing in contact with earth at many points.

Parliamentary.—*London United Tramways.* — The Eton Rural District Council has withdrawn its petition to the above Bill.

Rotherham Corporation Bill.—The Standing Orders Committee of the House of Lords has reported that standing orders may be dispensed with in the case of the above Bill, and that it may proceed, subject to the powers to construct tramways Nos. 5 and 6 being struck out.

L.C.C. (Tramways).—It has been decided by the Standing Orders Committee of the House of Lords that this Bill may proceed subject to tramways Nos. 6, 8, 8A, 8B, and 8C being struck out.

London United Tramways Bill.—The opposition of the Richmond Corporation and of a number of owners in Langford and Harmondsworth to this Bill, has been withdrawn.

New Group.—A Committee of the House of Commons, consisting of Mr. Russell Rea (chairman), Sir William Doxford, Mr. Joseph Walton and Mr. Nicholson has been selected to deal with the following Bills:—North and South Woolwich Electric Railway; Baker Street and Waterloo Railway; Charing Cross, Euston and Hampstead Railway; and the Torquay Tramways.

St. Marylebone Electric Lighting Bill.—The Gas Light and Coke Co. are asking for Standing Orders to be dispensed with so that they can oppose this Bill.

An E.C.C. Concert.—On Saturday evening in last week a concert, arranged by one of the departments of the Electric Construction Works, Bushbury, was held at the Duke of York Inn, Wolverhampton.

The Imperial Floating Exhibition.—We have received a booklet giving some particulars of the scheme promoted by the *Daily Express* for the chartering and fitting out of a steamship with samples of goods manufactured by British industrial firms. Owing to the space aboard being very limited, although the *Lake Megantic*, a vessel of about 5,500 tons, has been chartered, it is proposed that, except when found impossible for one firm to adequately represent a particular industry, one firm only in each trade shall be allowed to exhibit, manufacturing houses combining to make the show representative. The steamship will, it is hoped, leave London in May for a voyage round the principal ports of the Empire and countries which are important as markets for British products.

For Sale.—The Govan electricity department offers a three-wire Ediswan switchboard and a B.T.H. three-wire booster for sale. See advertisement pages to-day.

Book Notices.—*Garcke's Manual of Electrical Undertakings and Directory of Officials.* 1904 (eighth year). London: Mowbray House, W.C., 15s. net. This work is so widely used, and its merits are so fully recognised by all who have any consequential connection with the electrical industries, that it really seems hardly necessary to say much about the present edition. The mere mention of the fact that the 1904 issue is "out" will be quite sufficient intimation for those who wish to keep the business bookshelf up-to-date. But it is quite possible that some of our readers have not yet from personal experience found out what a serviceable book Garcke's Manual is to have at hand. It towers head and shoulders above all other publications of a like description, and for the benefit of those who do not know, we may say that it gives full information respecting every electrical undertaking worth including. In the 1904 edition the principal features are retained in their familiar shape. The information relating to electrical undertakings, both municipal and company, is again divided into five sections as follows:—(1) Electric lighting, traction and power; (2) telegraph and telephone; (3) manufacturing and miscellaneous; (4) directory of officials; and (5) list of electrical companies registered since 1856. These sections afford, as usual, a detailed record of the financial and other progress of every electrical undertaking to date. The customary statistical matter, based on the figures given in the body of the book, is given for the past year. It shows, among other interesting facts, that the amount of capital involved in electrical schemes has risen since 1902 from over £186,000,000 to nearly £227,000,000. The corresponding figure in the 1896 volume was over £61,000,000, showing that the magnitude of the business has nearly quadrupled within eight years. The average rate of dividend earned on the total capital was 4·89 per cent. in 1902; for last year it was 4·95 per cent. The detailed figures given show that this slight increase is made up of gains in the telegraph, telephone, supply, and miscellaneous

divisions set off against a slight reduction in the average traction dividend and a drop from 6·10 per cent. to 5·67 in the manufacturing section. There are many maps of power and tramway areas, electric railways, and of course the accounts of all electricity supply undertakings are detailed in the usual manner. The directory side of the work is also very strong.

Directory and Map of Automobile Charging Stations. 1903. London: *Electrical Times.* 3s. 6d. This directory will naturally become more important every year as the electromobile wins its way into the favour of motorists, and as electric supply works cultivate the automobile battery charging side of their business. We gather from the present edition of the work that there are now more than 700 places in the kingdom where the re-charging of motor and ignition batteries may be effected. The arrangement of the information is convenient, the name of the town being boldly brought out and accompanied by names and addresses of the works where charging may be done, particulars of the time, terms, &c., and a map of roads being also given. We think we have said sufficient to indicate the usefulness of the book without printing the notice sent to us by the publishers.

"The Motor Manual," by the Staff of *The Motor.* London: Temple Press, Ltd. 1s. net.

Liquidation.—A petition to wind up the Electric Timber-Seasoning and Preservation Co., Ltd., is to be heard in London on March 8th. The petitioner is Mr. L. de Layen, of Croydon, a creditor.

Bankruptcy Proceedings.—The first meeting of creditors was held at the London Bankruptcy Court on Friday last, under the failure of H. G. Ellis and G. L. Bastin, carrying on business at 3 & 4, High Street, Ilford, under the style of the Electrical Contract and Maintenance Co. The joint statement of affairs shows liabilities £661 3s. against £75 19s. 9d. The debtor Ellis states that the partnership was entered into about 12 months ago, but he formed the business in August, 1901. He had previously, from 1895 to 1899, traded as an electrical contractor in the name of H. G. Ellis & Co., at 66, Victoria Street, Westminster. Under the partnership deed, Mr. Bastin introduced a capital of £475, which converted a debit balance of £280 into a surplus of nearly £200. The failure is attributed to the excess of expenses over profits, loss of contract work, also to illness of Mr. Ellis. No offer was submitted by the debtors, and the chairman (Mr. E. L. Hough, senior official receiver) intimated that the case would remain in his hands to be wound up in the ordinary course of bankruptcy, the debtors' public examination being fixed for March 24th.

LIGHTING AND POWER NOTES.

Bangalore.—The Mysore Government has sanctioned the opening of negotiations with the object of making available, in the town, the surplus electrical energy now supplied from the Cauvery Falls to the Kolar Gold Fields, by tapping the transmission line which runs within 12 miles of Bangalore. It is proposed to place the work in the hands of a company operating under powers granted by Government. The company will be allowed to take energy from the Cauvery power scheme free of charge. The two municipalities of Bangalore, namely, of the native city and the civil and military station, have been invited to take advantage of this opportunity for electric street lighting at rates that will, it is stated, be below those paid in any other city in India.

Mr. Lusk, a representative of the B.T.H. Co., is in the district negotiating for a scheme for lighting the town by electricity and laying down tramways, and the company has offered to bear the cost of erecting and maintaining the proposed installation for lighting the streets.

Bath.—It has been decided to reduce the price of energy for power purposes to 1½d. per unit.

Bo'ness.—The Town Council has applied to the Secretary for Scotland for power to borrow the sum of £25,000 for its electric light undertaking.

Broughty Ferry.—The T.C. has resolved to extend its E.L. mains to Barnhill.

Caerphilly.—A free wiring scheme has been adopted by the U.D.C., the work to be carried out under contract by a private company.

Ceylon.—It has been decided to introduce as an experiment the "Stone" system, for lighting the railway coaches on the Government railways.

Chepstow.—Major Philip Cardew, in a report upon the arbitration proceedings between the Chepstow Gas Co. and the Electric Supply Co., states that the Electric Supply Co. did not comply with the conditions in respect to giving the Gas Co. not less than three days' notice before commencing to dig trenches near the gas mains, that the allegation made by the Gas Co. that the trenches were filled in, in an unworkmanlike manner was not proved, and that the electric supply mains were laid down in some portions in undue proximity to the gas mains. The award was that the Electric Supply Co. should pay the Gas Co. £36 6s. 6d. compensation, and expenses amounting to £44 7s. 6d.

Chorley.—The E.L. Committee has recommended the T.C. to request Mr. Oswin Hansom, of Fleetwood, to embody his proposals for taking over the E.L. order in the form of an agreement.

Cleckheaton.—The T.C. has resolved to apply to the L.G.B. for sanction to borrow a further sum of £4,000 for electric lighting purposes.

Darwen.—A L.G.B. inquiry was held on 23rd ult. in regard to the application of the T.C. to borrow £6,500 for electric lighting purposes.

Eccles.—The T.C. has resolved to allow the switchboard attendants in their spare time to canvass for new consumers, and to pay them 2d. for each 8.c.p. lamp connected. The cables are to be extended at a cost of £120.

Falkirk.—The Abbots Foundry Co. has resolved to introduce electricity into its works for lighting and power purposes, and to lay down the necessary plant at the foundry.

Farnham.—The B. of T. has revoked the 1900 prov. order.

Fleetwood.—The U.D.C. has decided to apply to the B. of T. for the revocation of the E.L. order, 1890, so far as those portions of the compulsory area in the district are concerned, in which the local lighting syndicate has made default in not supplying energy for public lighting.

Germany.—Work has been commenced on the installation for the municipal electric lighting scheme at Bantzen.

A scheme for lighting the town of Duisburg by electricity has been decided upon, at an estimated cost of £25,000.

Gloucester.—The T.C. has resolved to light the tramway routes with 123 arc lamps.

Gravesend.—The following is the output of the electrical undertaking during the past quarter:—Tramways, 101,032 units, against 21,833 last year; private consumers, 40,433 units, against 8,800 last year; public lighting, 22,300; works, 18,625; unaccounted for, 26,689; total units generated, 209,089, as against 38,460 last year.

Greenock.—Messrs. Scott & Co., shipbuilders, of this town, are having erected in their yard a 120-ton electric derrick crane.

Honley.—It is stated that the electricity works will be formally opened on March 21st.

Lincoln.—A L.G.B. inquiry was held on February 25th, relative to the application of the T.C. for a loan of £11,500 for electricity purposes; there was no opposition.

Liverpool.—A report dealing with electric supply in Liverpool, by Mr. A. Bromley Holmes, consulting engineer, was presented at the last meeting of the Electric Lighting and Power Committee. In the report it was recommended that the charge for energy to the Tramways Committee should be increased from 1·05d. to 1·12d. per unit, subject to the sliding scale based on the cost of coal. With regard to the consumption for lighting, the margin between the price paid by consumers of energy for lighting and power, and the cost of production, is much greater than is required to meet the anticipated increase in capital charges and rates for the coming year. The engineer states that under these circumstances it would not be advisable to raise the prices, as the sale of electrical energy for lighting is the most profitable portion of the business of the department; and, with a view to facilitate the adoption of electric light in small houses, he recommends the trial of prepayment meters.

In the course of a discussion on the report, Mr. Bromley Holmes pointed out that the Glasgow Corporation last year paid nearly £100,000 for 13,000,000 units for the tramways, while Liverpool only paid about £80,000 for 17,000,000 units. The charge at Liverpool was much too low. The increase which he proposed would, on the present consumption by the tramways, add about £4,500 to the present charge. The confirmation of the report was adjourned for a fortnight to afford the Tramways Committee an opportunity of considering it.

London.—L.C.C.—*Electric Lighting of Music Halls and Theatres.*—The Theatres Committee reported having given special consideration to the question of the precautions which should be adopted in premises licensed for public entertainments in order to minimise as far as possible the risk of fire or panic, and it was of opinion that certain additions to the existing rules should be made. The Lord Chamberlain was quite in accord with the committee in those suggestions, and, after a brief discussion, the County Council decided to incorporate the new rules with those now in force. Among these may be mentioned the following:—

No. 11.—Whenever the curtain is lowered, all lights in the auditorium, which are not controlled from the stage switchboard, must be lighted.

No. 19.—Where there is an electrical installation a properly qualified man must be in charge of such installation.

No. 20.—In all cases in which it is desired to install temporary lighting, notice must be given to the clerk of the Council, in writing, as long as possible before it is desired to commence the work

Wires and cables must be adequately and firmly fixed, and must be similar to the wires specified in the Council's regulations, and in all cases where the wires are within reach of the public, they must be cased.

All joints must be soldered and taped if used for more than one week, and if used less than a week the wire must be soldered, if larger than 7/20 S.W.G. or its equivalent. In either case the joints must be taped.

The circuits must be sub-divided as much as possible, no sub-circuit exceeding 10 amperes.

All temporary work must be immediately removed when no longer required for the purpose for which it was installed.

In the case of temporary work on the stage, all connections to the permanent installation must be removed immediately after each performance in which they are used, unless permission be obtained to the contrary.

Such special conditions as may be requisite in each case will be attached to the consent of the Council to the use of temporary electrical work.

No. 21.—All main switches, fuses, &c., which are the property of the electric supply company, shall be distinguished by being coloured red with a white band.

No. 22.—At least one pair of india-rubber gloves must be provided for the use of the electricians in connection with the electric lighting arrangements as a precaution in the event of high voltage occurring. The gloves must be kept on the stage switchboard and be kept in good order.

No. 23.—At least one bucket, filled with dry sand, must be kept in some accessible position on the stage in readiness for use in dealing with an electric fire, and one must also be kept in each of the intake rooms.

No. 24.—Communication must be established between a point on the stage, in close proximity to the releasing gear to the fire curtain and the telephone alarm in connection with the nearest fire brigade station.

It was decided to forward a copy of the rules, as altered, to the licensees of all places licensed by the Council for public entertainment.

Marylebone.—The Finance Committee of the B.C. has reported that no provision had been made in the estimates for any portion of the payments already made or in prospect under the electric lighting scheme. These are covered by the Bill now before Parliament, and if the Bill becomes law they will be chargeable to capital account. The amount of such payments to date is approximately as follows:—Cost of obtaining provisional order and confirming order, £1,491; Council's costs in connection with arbitration proceedings, &c. (subject to taxation, but £19,200 already paid on account), £31,000; costs of arbitration tribunal, £5,600; company's taxed costs *re* arbitration, &c., £10,725; counsel's fees for opinions and consultations, Prof. Kennedy's fees, and electric adviser's fees, £1,688; amount paid to the company under order of the Court, £60,000; further amount to be paid to the company by order of the Court on March 31st, 1904, £15,000; expenses of promotion of Bills in Parliament during session 1904, say, £2,000; total, £127,504. Of this amount about £29,000 has still to be provided, and a further arrangement with the bank for an overdraft may be concluded, Mr. Justice Buckley distinctly contemplating such an arrangement in his judgment.

Fulham.—In connection with a proposed extension of the electric lighting plant, the borough electrical engineer and the chairman of the Committee are to visit a number of works in the Midlands and inspect any turbine plants to which they can obtain access. Further street lighting extensions are to be carried out at a cost of £190.

Kensington.—Permission has been granted by the B.C. to the Brompton and Kensington Electricity Supply Co. to construct transformer street boxes in Scarsdale Villas and Gledhow Gardens.

Bermondsey.—The Thames Conservators have approved of the plan for laying cables in the river bed across the Lavender Dock entrance of the Surrey Commercial Docks at Rotherhithe.

Londonderry.—The C.C. has given permission for the erection of overhead wires for the transmission of energy for electric lighting along the road between Garvagh and Killyvalley.

Mytholmroyd.—The U.D.C. has signed an agreement with the Halifax Corporation for a supply of electricity from the Corporation tramways, at 2d. per unit net, for the purpose of supplying for motive power purposes.

Penrith.—The Ratepayers' Association has decided to oppose the application of the U.D.C. for a loan for the establishment of E.L. works.

Pollokshaws.—The special Electricity Committee of the burgh has been asked to draw up a report in regard to the terms on which the Clyde Valley Electrical Power Co. has offered to supply the burgh with electricity. The Committee has also been asked to confer with the Glasgow Corporation and get from it definite terms on which it would be willing to supply energy, or take over the lighting order.

Portadown.—The Council has received a communication from a person in Belfast, acting on behalf of a company regarding an electric lighting and power scheme in its district. It is stated that all capital will be found by the company, and that the cost of the scheme will be paid off in 25 years, the undertaking then to become the property of the Council. The Council is asked to obtain a prov. order, the undertakers to pay the cost, and any net profit will be divided between the company and the Council. The charges for energy will be, to private consumers, 6d. per unit for lighting, and 3d. and 1½d. per unit maximum demand, for power.

Rangoon.—The *Times of India* states that in view of the Brush Co.'s alleged inability to carry out its Shanghai concession, the Municipal Committee adopted a resolution to ask the company what guarantee it is prepared to give the Municipality for carrying out the electric lighting and traction scheme if it is granted the license. It has been ascertained that the Government is not competent to grant a license for more than 42 years, and the company has been asked if it is willing to accept the concession for that period, and whether it is willing to pay any excess which might be fixed by arbitration above the four lakhs of rupees which is the price the company has agreed to pay for taking over the existing tramways.

Rotherham.—A L.G.B. inquiry was held last week into the application of the T.C. to borrow £14,670 for E.L. purposes. The sum of £7,340 was stated to be for present extensions, and the balance for those contemplated within the next two years. An additional 100-ampere battery is to be installed. The price of energy for power has recently been reduced from 1½d. per unit to 1d. per unit to large consumers. It was stated that for street lighting the present plant could be used, but at present the Council did not propose to light the streets by electricity.

St. Austell.—Messrs. Pressland & Frippard have informed the T.C. that some clients of theirs propose taking over the control of the Council's order with a view to laying down an entirely new generating plant for the supply of electricity to the town. The T.C. has resolved to ask for information as to the company whom Messrs. Pressland & Frippard are acting for.

St. Annes.—On February 25th a L.G.B. inquiry was held into the application of the U.D.C. for a loan of £4,000 for extensions to the electricity works and plant. There was no opposition.

Salford.—The Corporation Electricity Committee has resolved, subject to the T.C.'s approval, to reduce the flat rate charge for energy for lighting purposes from 4d. to 3½d. per unit. This will take effect from July 1st next. From the same date there will be a reduction of the quarterly rent charges for meters. The Committee recommend the Council to apply to the B. of T. for borrowing powers to such an amount as will cover the cost of the cables for supplying energy to the tramways in Eccles, Swinton, Prestwich and Whitefield. The respective amounts will be:—Eccles, £3,377; Swinton, £2,247; Prestwich and Whitefield, £3,600.

Seaham Harbour.—At the meeting of the U.D.C. on February 23rd, the Lighting Committee reported that a deputation had attended to ask its consent to the obtaining of a prov. order to supply electricity for tramway and lighting purposes for the district. They explained that, after obtaining the order, they could speedily supply the light, but could not at present bring the trams into the Council's district. The Committee recommended that consent be not given to the application. The County of Durham Electrical Power Distribution Co. was also represented, and asked for a further opportunity of negotiation with the Council for its consent to the proposed application next session.

Southend.—Mr. W. E. G. Heenan, the borough electrical engineer, has recommended the T.C. to install a Babcock and Wilcox boiler at the electricity works, and also that an additional five bogie cars be obtained to cope with the coming season's traffic.

Sowerby Bridge.—Three schemes for supplying energy to the Council have been submitted by the Halifax T.C., *i.e.*, in bulk to the gasworks, machinery to be provided by the Halifax T.C., and buildings by the Sowerby Bridge U.D.C.; in bulk to the station at Albert Road, machinery and buildings to be provided by the Halifax T.C., a minimum consumption of 18,500 units per annum at 2⅝d. per unit under the first scheme, and at 2½d. per unit under the second is asked for; and to supply energy under the U.D.C.'s Order in the compulsory area for not less than 10 years, at 5d. per unit for lighting, and 2d. for power.

Spain.—It has been decided to negotiate for the supply of energy for the electric lighting for 20 years of the towns of La Solana and Membrilla (La Mancha). The former municipality will require about 2,000 c.p., and will pay about £173 per annum, and the latter about 1,250 c.p., and pay £116 per annum.

Stoke-on-Trent.—The L.G.B. has sanctioned the borrowing of £17,840, by the Corporation for E.L. purposes, and £12,800 for the provision of a refuse destructor.

Sydney (N.S.W.).—A scheme for a loan of £250,000 in connection with the Council's scheme for electric lighting, submitted a few weeks ago by the city treasurer, has been adopted, and tenders were ordered to be invited locally.

The Lord Mayor recently stated that provision has been made in the E.L. scheme for the erection of 600 arc lamps for public lighting, of which 340 are being erected as a first instalment.

Todmorden.—The T.C. has decided to apply for borrowing powers to the amount of £20,000 in respect of its electricity works.

Wallsend.—A floating coal depôt, launched at Messrs. Swan, Hunter & Wigham, Richardson's yard last week, for the British Navy, has been equipped with electrically-driven transporters, and it is estimated that it is capable of transferring about 500 tons per hour. The storage capacity is about 12,000 tons.

Worcester.—The municipal electricity works made a net profit of £1,693 last year. This is stated to more than equal a 2d. rate.

Willesden.—The Works Committee of the U.D.C. has recommended that proceedings be taken against the Metropolitan Electric Supply Co. to restrain it from supplying electricity to the L. & N.W.R. at the Brent sidings. This was adopted.

Wisbech.—On the recommendation of its E.L. Committee, the T.C. has resolved to negotiate with Messrs. Edmundson's and the National Electric Wiring Co. to ascertain the terms upon which they would be willing to instal the electric light into its area. It has been decided to compare the results of the negotiations with the scheme drawn up by Messrs. R. Hammond & Son.

Wood Green.—It was pointed out at a recent meeting of the T.C. that its E.L. order will expire in July next, and in view of this the Council has resolved to make application to the L.G.B. for sanction to borrow £7,600, for the purpose of laying mains in the compulsory area.

TRAMWAY AND RAILWAY NOTES.

Birkenhead.—A loan of £5,000 has been applied for by the T.C. for the provision of top covers for the electric trams.

Campbeltown.—The proposal of a syndicate to establish an electric railway between Campbeltown and Machrihanish for passenger traffic is being viewed with favour by the T.C. and other local bodies. The undertaking is estimated to involve an expenditure of between £20,000 and £30,000. The new railway will tend to open up and develop the district for tourist traffic.

Croydon.—The R.D.C. has informed the T.C. that it does not intend to introduce the Coulsdon Tramways Bill in the present session of Parliament.

Dudley.—The town clerk has been authorised to apply to the B. of T. for the appointment of a referee, as provided by the agreement of October 17th, 1898, and the various orders relating thereto in order to decide the terms of purchase by the Corporation of the tramways and light railways in the borough now operated by the British Electric Traction Co.

Electric Railways.—The *London Gazette* for March 1st contains a copy of the statutory rules made by the Board of Trade in February, 1904, with respect to applications under the Railways (Electrical Powers) Act, 1903. The rules will be placed on sale as a Government publication.

Farnworth.—The U.D.C. has, after two months' negotiations, resolved to lease the tramways to Salford T.C.

Glasgow. — The Committee has decided to witness the process of welding car rails by electricity, which is at present being carried on in the city.

Halifax.—The manager of the Corporation tramways, Mr. Fredk. Spencer, was instructed to inquire as regards the efficiency and cost of the Hewitt & Rhodes pneumatic slipper brake. He has reported as follows:—

> It is, no doubt, a very excellent and effective brake, and would do all that is claimed for it. This, however, is no more than is now done with our present brakes. On the other hand a driver putting on our present brake can feel its application, and thus be satisfied of its immediate effect. This is not furnished by the pneumatic action. If our system were in an initial stage, this new brake would merit every consideration, but it would cost £65 per car to equip, thus adding £6,000 to capital without any corresponding advantage.

Keighley.—The T.C. has decided to convert the tramways to electric traction on the overhead system, and to apply to the B. of T. for a loan of £42,790 for the work.

London.—L.C.C.—At Tuesday's meeting a report was submitted by the Highways Committee on Prof. Kennedy's agreement. The report stated that as the Council's officers would be responsible for the greater portion of the work in connection with the establishment of the Greenwich power station, Prof. Kennedy had suggested that in order to ensure uniformity of control, and having regard to the small extent of work which remained to be carried out under the terms of the agreement, the latter should be terminated in so far as concerned the generating station work, on the basis of his receiving 2 instead of 4 per cent. on the cost of the electrical plant and equipment for which he is responsible, and 1 per cent. on the actual and estimated cost of the buildings for which the consulting engineer had been or would be responsible. The Committee had come to the conclusion that the course proposed should be taken, and the Council adopted a recommendation to that effect.

At the meeting on Tuesday an expenditure of £6,600 was sanctioned for the reconstruction as double-conduit lines of the single line in Goswell Road between Clerkenwell Road and Upper Ashby Street.

Holborn.—The B.C. Works Committee favours the adoption of the trolley system instead of the conduit as proposed by the L.C.C. It has been decided to take the views of the inhabitants before asking the Board of Trade to withhold approval from the L.C.C. proposal.

Wandsworth.—The L.C.C. is endeavouring to acquire a site for a station on the north side of Wandsworth Common. The B.C. is demanding the removal of the feeder-pillars in Upper Tooting Road and Balham High Road.

Melbourne.—The Melbourne correspondent of the *Daily Chronicle* says that the Government has vetoed the application of a group of municipalities who seek to provide electric tramways in the suburbs of Essendon, Flemington, Moonee Ponds and Newmarket, because it fears that traffic will be diverted from the unwisely located suburban railway lines. The municipalities have in vain contended that the routes they have agreed with their contractor to serve do not compete with the Government railways; on the contrary, they have shown that the new electric trams would actually be feeders to the trains. As the Government exhibits no sign of a determination to construct the needed tramways itself and seems prepared to violate the provisions of the Local Tramways Act in order to block the municipal scheme, a very interesting situation has been created. The municipalities may go to the Privy Council.

Mid-Cheshire.—The Mid-Cheshire Tramways Co. is applying to Parliament for rather extensive powers. It is proposed to purchase the existing Stockport and Hazel Grove light tramway, to electrify this, and continue the line through Poynton and Adlington to Macclesfield, where a complete system of borough tramways is to be organised, and ultimately to make connections with Sandbach, Crewe, and Nantwich, with branches to Knutsford and Warrington. There is to be a generating station at Poynton on land to be acquired from Lord Vernon, and in close proximity to the Poynton Colliery. Power is also being sought to supply electrical energy to local authorities. There is a period of five years fixed for the completion of the works. The gauge of the tramway, in order to meet the approval of the County Council, has been fixed at 4 ft. 8½ in.; there can, therefore, be intercommunication with Stockport and other towns. The capital of the company is fixed at £200,000, in £1 shares, one-fifth of which has to be subscribed before allotment. Interest is to be provided for out of capital during construction. The directors' qualification is 500 shares; the first directors are Messrs. Leonard Cooper, George Pearson, and T. C. Beeley. The estimated cost of the undertaking is £197,000.

Perth.—The T.C. on 25th ult. held a special meeting to consider the proposed reconstruction of the tramways. Mr. Dawson, of Messrs. Kincaid, Waller, Manville & Dawson, was present and answered a variety of questions in regard to the undertaking. The discussion lasted for nearly three hours, no fewer than four motions being submitted to the meeting. Ultimately it was decided by 12 votes to 9 to adopt the amendment to delay taking any further action meantime, the object being to give the ratepayers an opportunity of discussing the question. A motion, which was lost by 3 votes, was to the effect that the Council approve generally of the report, and instruct the engineer to prepare the necessary plans and specifications with the object of getting in estimates for the work proposed to be carried out. Two of the members did not vote. A further meeting of the Council will probably be called in a fortnight, when it is expected that a final vote will be taken on the question of reconstruction.

Rowley Regis.—The U.D.C. has accepted the tender of the Birmingham and Midland Tramways Co. for the construction of the tramways and the provision of the parts of the electrical equipment, and to apply for a loan of £27,680 to cover the cost.

Wolverhampton.—The Dudley Road section of the new tramway system is completed, and it only awaits the B. of T. inspection. This is the line that ought to have been completed before Christmas. The construction of the Willenhall-Road section is being pushed on, and it is expected that it will be in readiness for the Easter holiday traffic.

TELEGRAPH AND TELEPHONE NOTES.

Glasgow Telephones.—The Telephone Committee have appointed several of their number to consider and report on the whole question of electrophones. The remit followed a letter from the Postmaster-General. The Committee have agreed to apply to the Secretary for Scotland for additional borrowing powers to the extent of £50,000 in order to carry on the further development of the telephones. The borrowing powers authorised, £300,000, are exhausted, with the exception of £16,900.

Hull Telephones.—The Municipal Telephones Committee has completed an agreement as to inter-communication with the National Telephone Co.

International Code Telegraphy.—The Postmaster-General has forwarded to the London Chamber of Commerce a copy of the revised rules respecting code language and cypher in international telegraphy which will come into force on July 1st next. The Postmaster-General has addressed a letter to the compilers of codes who, it is understood, are drawing up new editions, pointing out that whilst the conference in London in 1903 had decided to admit artificial combinations on the same footing as real words, the admission of such artificial combinations to the benefit of code language rests on the assumption that they will be easy to transmit, and the use of expressions which are difficult to pronounce, and, consequently, to transmit, would be regarded as a breach of the spirit of the regulations, which should be avoided by the public, in the interests of the rapid and accurate transmission of their telegrams.

London Telephones.—In reply to a question asked in the House of Commons last week, Lord Stanley said that the expenditure on the London Telephone Exchange system amounted to £1,495,602 on December 31st last. The system was not complete. Its extension was dependent on the provision of further funds by Parliament, and he hoped shortly to move a resolution for leave to introduce a Bill to provide additional capital for this purpose. It had been necessary to restrict the expenditure on telephone works in London, and to reduce the number of workmen employed in order to avoid exceeding the expenditure authorised by Parliament. If further expenditure were authorised at an early date, the works would be pressed forward as rapidly as possible.

New Cable to Japan.—A Reuter dispatch from Washington says:—"On the ground that the use of commercial facilities does not constitute a breach of neutrality, the Government has decided to sanction the laying of the new telegraph cable between the Japanese coast and Guam Island, to connect with the Pacific cable. The object of the projected cable is to prevent the isolation of Japan in the event of Russia's cutting both existing cables between Japan and Shanghai." Another dispatch says that no formal application has been made to the Government, though its feeling has been tested on the matter.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1903	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Rome-Pera	Feb. 29, 1904	
Tarifa-Tangier	Jan. 18, 1904	
Oran-Tangier	Feb. 3, 1904	
Closed { Nagasaki-Vladivostock	Feb. 15, 1904	
Closed { Port Arthur-Chefu	Feb. 18, 1904	
Landlines.		
Seoul-Masampo	Feb. 13, 1904	
Seoul-Gensan	Feb. 13, 1904	
Anju-Ping-Yang	Feb. 25, 1904	

CONTRACTS OPEN AND CLOSED.

OPEN.

Aston Manor.—March 14th. Water-tube boilers, superheater, and stoker. See "Official Notices" February 26th.

Austria.—March 20th. The Municipal Authorities of Retz are inviting tenders until March 20th for the establishment of a central electric lighting station in the town.

Belfast.—March 11th. Motors, cables, conduits, piping, bitumen, house service cut-outs, &c., for the Electrical Department. See "Official Notices" February 26th.

Caerphilly.—March 7th. Free wiring proposals for the U.D.C.

Canary Islands.—March 23rd. Electric tramway between San Cristobal de la Laguna and Tacoronte (Canaries). See this column for February 19th.

Chili.—June 28th. Electric lighting of the city of Punta Arenas (Straits of Magellan). See this column for February 19th.

Edinburgh.—March 14th. Arc lamp carbons, box frames and covers, for one year. See "Official Notices" February 26th.

Finchley.—March 12th. Free wiring proposals. See "Official Notices" February 26th.

Gainsborough.—March 16th. Telephones and fire alarms for the U.D.C. See "Official Notices" February 19th.

Gravesend.—March 12th. Stores, &c., for the Electricity Department. See "Official Notices" February 26th.

Hackney.—The Guardians invite tenders for providing and fixing electric light fittings in connection with the lighting of the casual wards and other buildings in course of erection at Gainsborough Road, Hackney Wick, N.E. Mr. W. A. Finch, of 76, Finsbury Pavement, E.C., is the Guardians' architect.

Ilford.—March 8th. Stores for the Electricity Department. See "Official Notices" February 26th.

Ilford.—March 22nd. One 1,000-kw. steam dynamo, switchboard work, condensing plant, water purifying plant, pipe work, cables, &c. See "Official Notices" February 26th.

Lincoln.—March 21st. Water-tube boiler, engine and C.C. dynamo. See "Official Notices" to-day.

Loughborough.—March 12th. Dryback boilers, condenser, and battery for the electricity works. See "Official Notices" February 26th.

Manchester.—March 7th. Stores for the Tramway Department. See "Official Notices" February 26th.

Manchester.—March 10th. 5,000 yds. of 1-in. feeder cable; also substitution of high voltage fittings for low voltage fittings on consumers' premises in the south-eastern district of the city. Specifications, &c., of Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. £1 1s. each specification.

May Oatway Installations.—March 9th. Fire alarm wiring in Aberdeen and Edinburgh. See "Official Notices" to-day.

Metropolitan Asylums Board.—March 8th. Tenders are invited for fire alarm and telephone installations at Caterham. See "Official Notices" February 19th.

Metropolitan Asylums Board.—March 22nd. Fire alarms and telephones, at Leavesden Asylum. See "Official Notices" to-day.

Newport (Mon.).—March 21st. Boosters, balancers, switchboards, tramway poles, overhead work, section pillars, cables, and trolley wire for the Corporation. See "Official Notices" to-day.

Norwich.—March 14th. Cables, wires, lamps, meters and crane for the Electricity Department. See "Official Notices" to-day.

Poplar.—March 12th. Two 1,000-kw. turbo-alternators (three-phase), and condensing plant. See "Official Notices" to-day.

Salford.—March 19th. Electric fittings, lamps (arc and incandescent), cables, pipes, &c. See "Official Notices" to-day.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" January 15th.

Spain.—March 20th. The establishment and working during a period of 20 years, of a telephone exchange in the town of Figueras. See this column for February 26th.

Spain.—March 21st. Electric tramways in the town of Seville. See this column for February 19th.

Spain.—March 28th. Tenders for the lighting of the town of Plasencia.

Stepney.—March 14th. 1,000-kw. steam turbine-driven double current generator, Babcock boilers, economisers, induced draught, piping, &c. See "Official Notices" February 26th.

Sunderland.—March 31st. India-rubber cables for a year. See "Official Notices" to-day.

Sweden.—The municipal authorities of Malmo are about to invite tenders for the working of several lines of tramways by electricity.

Wallasey.—March 16th. A.C. transformers for two years. See "Official Notices" February 26th.

Warrington.—March 14th. Paper cables and electric motors for 12 months. See "Official Notices" to-day.

Weymouth.—March 7th. Lighting the Corporation's generating station, and supply of meters. See "Official Notices" February 19th.

Wimbledon.—March 18th. Stores for the Electricity Department. See "Official Notices" February 19th.

Wrexham.—March 12th. Stores for the Electricity Department. See "Official Notices" February 19th.

CLOSED.

Aberdeen.—Messrs. J. G. White & Co. have placed an order with the British Thomson-Houston Co., Ltd., for six double motor equipments for the Aberdeen suburban tramways.

Bedford.—The Corporation has accepted the tender of the British Thomson-Houston Co. for high-tension switchboard at the electricity works.

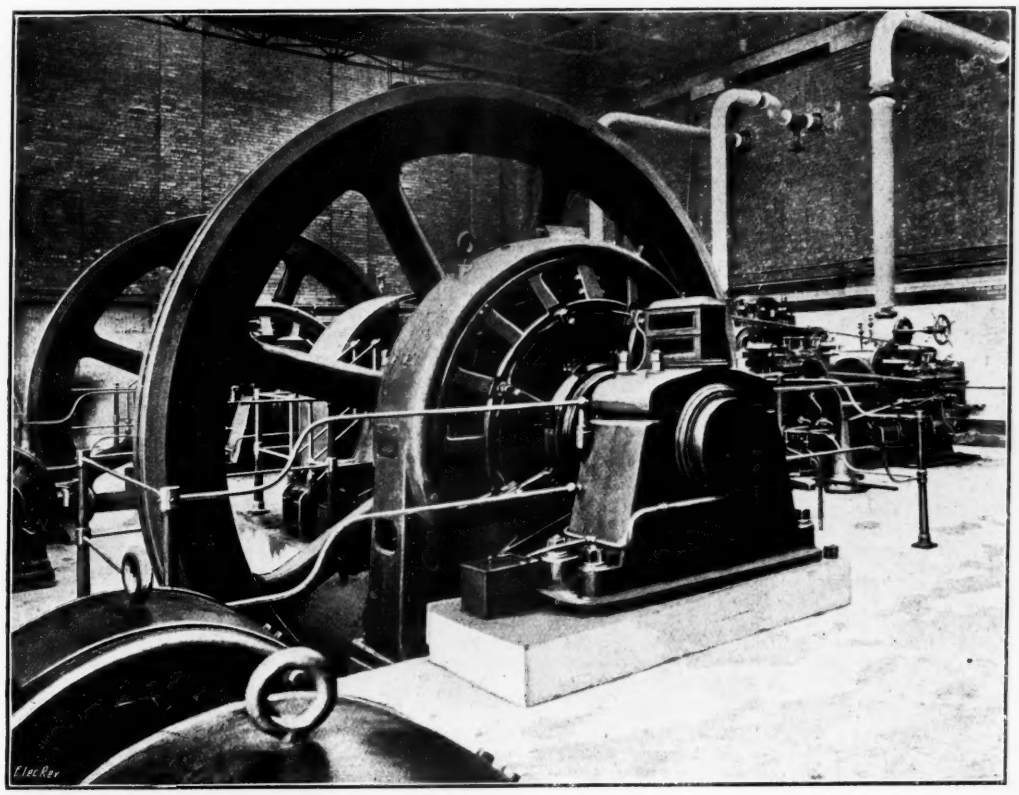
Cardiff.—Messrs. Bolckow, Vaughan & Co., Ltd., have secured the contract for the supply of steel rails, fishplates, nuts, &c., required by the Tramways Department of the Cardiff Corporation. In spite of the fact that a tender was received from Brussels offering to supply 105 lbs. and 111 lbs. rails and also fishplates at £5 11s. per ton, the tender of Messrs. Bolckow, Vaughan & Co. to supply the rails and fishplates at £5 15s. per ton was accepted. The Barrow Hematite Steel Co.'s tender was for £6 9s. 6d. for both classes of rails and £7 9s. 6d. for the fishplates, while the North-Eastern Steel Co., of Middlesbrough, offered to supply the rails and fishplates at £5 19s. per ton.

(*Continued on page* 387.)

BATH ELECTRIC TRAMWAYS.

Although the city of Bath is not a large one, it is one of the most famous in our annals, and is important both as a commercial centre and as a popular health resort. It lies in a valley, about 12 miles from Bristol, and as the tramway systems of the two cities are separated by only a few miles, it is not unlikely that in the future they may be connected.

The tramway scheme was originated by the Bath Electric Tramways, Ltd., and Messrs. George Hopkins & Son, of Clun House, London, W.C. The engineers were Messrs. Harper Bros. & Co., and Mr. R. D. McCarter, of London; Mr. C. Chadwell, of London, received the main contract, and carried out the construction of the track and the overhead equipment, and the laying of the feeders. The British Westinghouse Electric and Manufacturing Co., Ltd., were the contractors for the erection and equipment of the generating station, car-shed and office buildings, and the electrical equipment of 40 cars, which were made by Messrs. Milnes, of Hadley. Mr. R. D. McCarter is the general manager and engineer for the Tramway Co.



View of Generating Plant.

The power station was built and equipped by the Westinghouse Co. in less than 7½ months from the commencement, an achievement which is claimed as a record. The Board of Trade inspection took place on December 12th, 1903, and the system was opened for traffic on January 2nd last, the official opening ceremony taking place on February 13th.

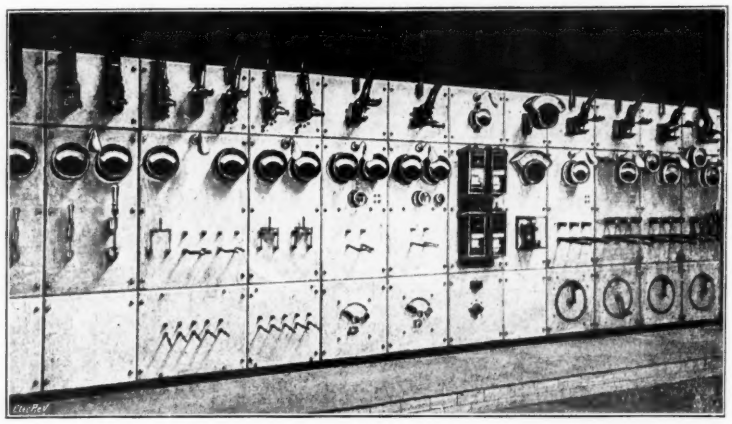
The length of the lines now in operation comprises nearly 16 miles of single track, the total length of the routes being 12⅓ miles. The construction of another mile of route is authorised. The gauge is 4 ft. 8½ in. The steepest grade is 1 in 11, and is 4 chains long; the worst gradient, however, is 1 in 14, 18 chains long. The sharpest curve is of 37 ft. radius, and there are four of less than 40 ft. The system, as shown in the map on p. 386, consists of four routes radiating from Southgate Street, in the centre of the city, two of them with short spurs, and one with an elongated loop. The extra mile of route which is authorised will go to form two loops in the city itself.

The generating plant comprises three 200-kw. Westinghouse "engine-type" direct-current generators, which are coupled to Yates & Thom compound engines running at 100 r.p.m., and one 75-kw. direct current generator coupled to a Westinghouse compound engine running at 300 r.p.m. The three large sets are used for feeding the tramway system, while the small one acts as an auxiliary on the traction load, and also supplies current for lighting the station, car-shed and offices.

The buildings are situated in Walcot Street, Bath, on the banks of the River Avon, from which water is obtained for feed and condensing purposes. Much of the site is made ground, in consequence of which the engine foundations had to be carried down nearly 30 ft., while the old river wall was found to be insecure, and had to be rebuilt. The buildings consist of a boiler house, engine house and car-shed.

The boiler house is 93 ft. long and 49 ft. wide; the engine and generator house are of the same length, but 2 ft. wider. The car-shed is about 130 ft. long and 82 ft. wide. Over the street end of the car-shed are various rooms for offices,

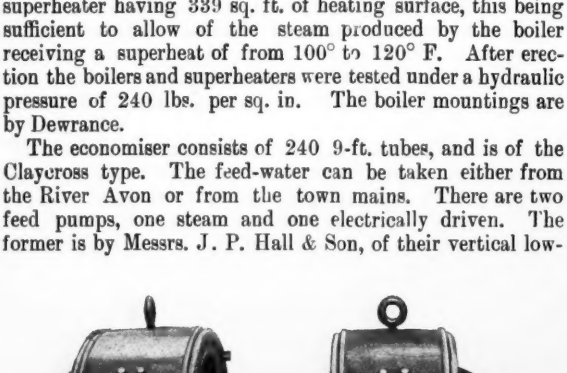
&c., while at the rear end is a large basement which is used as a repair shop. The engine room walls inside are of glazed brick to a height of 10 ft.; and the roof trusses and the purlins for slating are entirely of steel. The iron and steel constructional work was done by Messrs. Lysaght and Co., and the glazing by Messrs. Mellows, as sub-contractors to the Westinghouse Co. The engine foundations extend some 25 to 30 ft. below the floor of the engine room, the floor being of concrete finished with cement. The chimney shaft is 140 ft. high, and 7 ft. in diameter at the top under the cap. It is of sheet steel, lined inside with brick to a height of 60 ft., and was built by the British Westinghouse Co. The chimney rests on a bed of concrete and brickwork, and though self-supporting, is held down by bolts as an extra precaution. It is fitted with a permanent ladder.



Main Switchboard.

The steam plant comprises three Babcock & Wilcox boilers, each with a heating surface of 3,140 sq. ft.; each boiler is normally capable of evaporating 11,000 lbs. of water per hour, with a maximum of 13,000 lbs. per hour, the working pressure being 160 lbs. per sq. in. The grate area per boiler is 59½ sq. ft. Each boiler is fitted with a superheater having 339 sq. ft. of heating surface, this being sufficient to allow of the steam produced by the boiler receiving a superheat of from 100° to 120° F. After erection the boilers and superheaters were tested under a hydraulic pressure of 240 lbs. per sq. in. The boiler mountings are by Dewrance.

The economiser consists of 240 9-ft. tubes, and is of the Claycross type. The feed-water can be taken either from the River Avon or from the town mains. There are two feed pumps, one steam and one electrically driven. The former is by Messrs. J. P. Hall & Son, of their vertical low-



Motor-Driven Booster.

speed type, and was supplied by Messrs. S. Sugden, Ltd.; the latter is a Blake & Knowles three-throw pump, and is driven by a Westinghouse direct-current motor. Each Hall pump is capable of delivering from 1,800 to 2,700 gallons of water per hour against the boiler pressure. The Blake and Knowles pump can drive 2,700 gallons of water per hour against the boiler pressure when running at 40 r.p.m. There are also two make-up pumps by Blake & Knowles, each of these having a capacity of 300 gallons per hour. The two surface condensers, by the Wheeler Condenser & Engineering Co., Ltd., have a combined cooling surface of 2,820 sq. ft., and are together capable of dealing with 28,000 lbs. of exhaust steam per hour at normal load, and 35,000 lbs. for one hour as a maximum, the circulating water being obtained from the River Avon. Two Wheeler combined air and circulating pumps were supplied by Messrs. Fraser & Chalmers, Ltd. The whole of the piping for the steam, exhaust, feed and circulating water was supplied by the Sir Hiram Maxim Electrical and Engineering Co., Ltd.

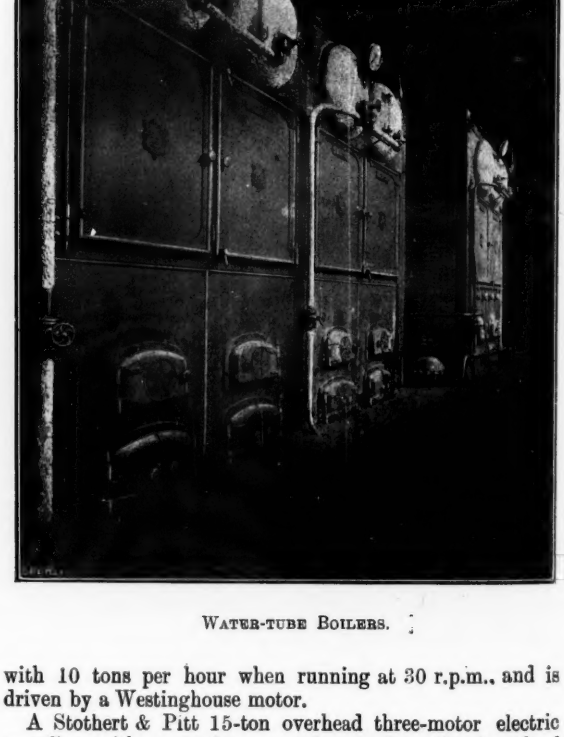
The Holly steam loop and gravity system is installed for taking care of the high-pressure drains, this being entirely automatic in its action, and free from all moving parts.

The water softener and purifier are by Messrs. Masson, Scott and Co. The former has a capacity of 300 gallons of water per hour, and the purifier a capacity of 1,250 gallons per hour.

The major portion of the oil is first removed by a Holden & Brooke extractor, and the Masson & Scott purifier then removes the emulsified oil as well as all oil remaining in suspension, and produces a thoroughly pure water for boiler-feed purposes.

The main steam piping is 12 in. in diameter, and the branches 6 in., with 3-in. pipes to the pumps. The system is fitted with Hopkinson valves. An automatic relief valve is fitted in the main exhaust pipe, which is 16 in. in diameter, with 11-in. branches to the engines.

The coal is carried straight from the railway trucks to the storage bins by "screw" conveyors made by the Conveyor and Elevator Co., of Accrington; the bins have a capacity of 50 tons. A spiral coal conveyor brings the coal from the store to the front of each boiler; this can deal



Water-tube Boilers.

with 10 tons per hour when running at 30 r.p.m., and is driven by a Westinghouse motor.

A Stothert & Pitt 15-ton overhead three-motor electric traveller, with a 50-ft. span, traverses the entire length of the engine room. It is fitted with Westinghouse motors and controllers, and has two lifting barrels, one for full load and one for light loads.

The three Yates & Thom horizontal tandem single-crank compound condensing engines have cylinders 15 in. × 30 in.

in diameter and 36 in. stroke, and Corliss valve gear. They are of 320 H.P. each, and give this output, both condensing and non-condensing. The Corliss valves are worked by trip gear of the Dobson pattern; and the centre weight governor with cross arm is such as to keep the speed constant within 2 per cent. A sensitive emergency knock-off appliance is fitted to the governor. The crankshaft of each engine is of mild forged Siemens steel, 16 in. diameter at the fly-wheel, and 14 in. diameter at the bearings. The fly-wheel of each engine is 16 ft. in diameter and weighs 18 tons. Under condensing conditions, and with the steam at 100° F. superheat, the steam consumption at full, three-quarters, and half-load does not exceed 15¼, 15¾ and 17 lbs. per horse-power-hour respective.

Side-pole Construction in Suburbs.

The three 200-KW. Westinghouse direct current traction generators are eight-pole machines and develop a pressure of 500—550 volts. The armatures are pressed on to the engine shafts, and are of the slotted drum type, with two-circuit windings so arranged that the circuits will not become unbalanced by a displacement of 1/8 in. from the geometric centre of the fields.

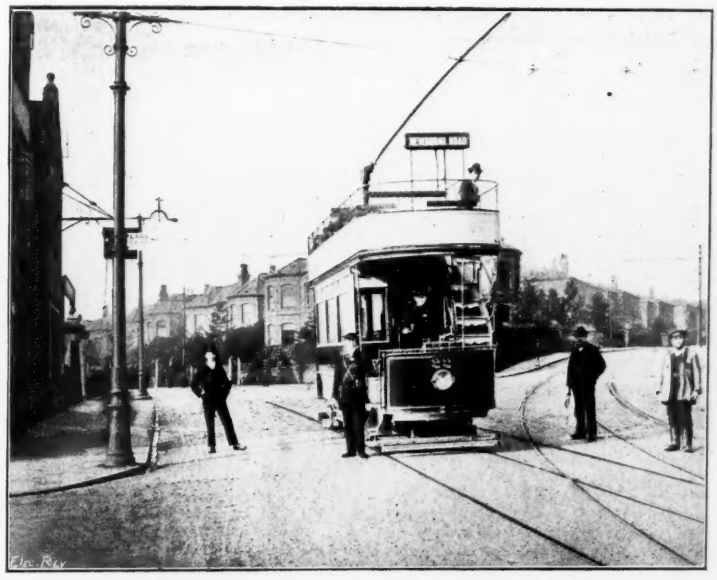
The insulation of both armature and field coils is flashed with an alternating pressure of 3,500 volts. The generators are capable of standing an overload of 25 per cent. for half an hour, and one of 50 per cent. for short periods. With a full-load run of one hour, the temperature rise did not exceed 40° C. above the surrounding air; while with a half-hour's run at 25 per cent. overload, the rise did not exceed 50° C. At full, three-quarters, half, and quarter load, the efficiencies work out at 93, 92·5, 91·5, and 88 per cent. respectively. Each of the machines was submitted to the following special test:—With the no-load voltage adjusted to 500, a load of 547 amperes (with such increase of voltage as was maintained owing to the combined series and shunt excitation) was put on to the machine for a short time; the main circuit was then suddenly opened, but the machine did not "buck," nor did any serious sparking occur.

The 75-KW. lighting and auxiliary traction set comprises a Westinghouse high-speed vertical enclosed two-cylinder single-acting compound engine, and a Westinghouse traction generator. The high and low-pressure cylinders of the engine are 11 in. and 19 in. diameter respectively, and the stroke 11 in. The generator is a four-pole 75-KW. machine, developing some 150 amperes at from 500 to 550 volts, the set running at 300 r.p.m. The armature of the generator is pressed direct on to the extended crankshaft of the engine. The machine is compounded so as to give a P.D. of 550 volts with the full load of 136 amperes, and it can carry this load continuously. The machine will also carry a 25 per cent. overload for half-an-hour, and a 50 per cent. overload for a few minutes. At full load its efficiency is 91 per cent.; at three-quarters load, 90 per cent.; at half-load, 89 per cent.; and at quarter-load, 86 per cent. A special test was applied to it similar to that to which the large generators were subjected. The temperature test showed that with 24 hours' full load no part of the machine rose more than 40° C. in temperature, while with a half-hour's run with 25 per cent. overload the rise did not exceed 50° C.

The two 15-KW. Westinghouse boosters are four-pole machines running at 575 r.p.m., the motor volts being 500, and the booster volts 50.

The main switchboard consists of 13 white marble panels 2 in. thick, set in an angle-iron frame. The various instruments are of the well-known British Westinghouse types, and include a combined bus-bar and paralleling voltmeter mounted on a swinging bracket.

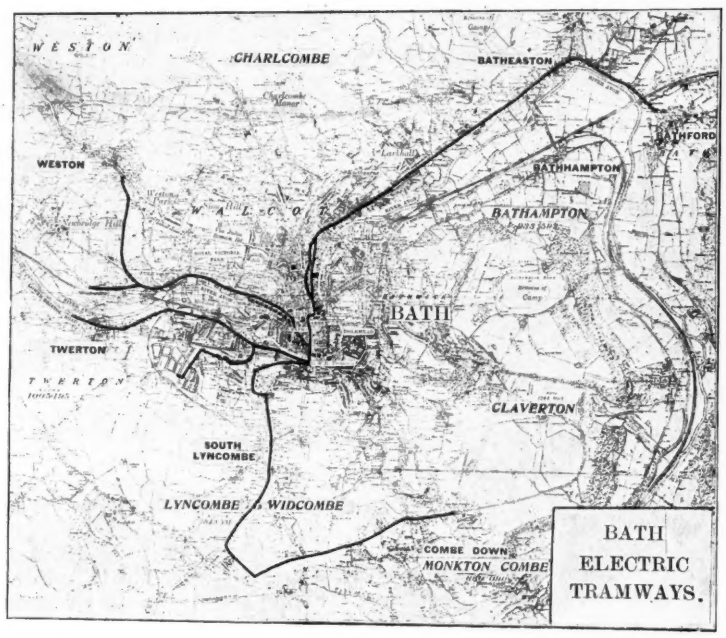
As mentioned at the beginning of this article, Mr. Charles Chadwell undertook the laying and equipment of the track and the feeder cables. The concrete bedding for the track is 6 in. thick, the web of the rails being also filled in with cement. The rails are in 45-ft. lengths, and weigh 95 lbs. per yard. The rails, fish-plates, bolts and nuts were supplied by the North-Eastern Steel Co., of Middlesbrough, and it was stipulated that, in the chemical analysis of the rails, neither the sulphur nor the phosphorus should exceed ·08 per cent. each; that the sulphur, phosphorus and silicon together should not exceed ·18 per cent.; and that the manganese should not exceed 1 per cent. Some 300 yds. of double track are laid on 8-in. × 4-in. longitudinal sleepers in front of the hospital in Lower Borough Walls. The rails are cross-bonded every 33 yds., the bonds being "Crown" 0000 B. & S. gauge, with ⅞-in. nipples. These were supplied by the American Steel and Wire Co. The points and crossings were supplied, and the special track work done, partly by Hadfield's and partly by the Lorain Steel Co. Wood paving is laid between the tracks in the centre of the city, and



Double-deck Car at Junction.

granite setts and macadam with granite paving on the outlying portions.

The overhead line is mostly supported on brackets, varying from 6 to 28 ft. in length, on side poles; but, in some parts of the city span-wires, with supporting rosettes, are stretched from the fronts of the houses. The rosettes were supplied by Messrs. Stuart and Lloyd, and the pole-bases by Messrs. Wm. Bain & Co. The poles are in three pieces, and stand 24 ft. high over all. There is no centre-pole construction. The trolley wire was supplied by Messrs. Fredk. Smith and Co., Manchester, and is of hard-drawn copper, ·364 in. in diameter. The guard wires are of galvanised steel, earthed through the poles, every third one of which (in the guard wire sections) is bonded to the rails. The ears are of the ordinary type, and both mechanical and trailing frogs are used. The ears were got from the Electric Tramway Equipment Co., who also supplied some of the frogs, the remainder of the latter being manufactured by Messrs. Brecknell, Munro & Rogers. The average length of the sections is ½ mile; some of the section boxes contain feeder switchgear, and one of them a Board of Trade panel. These boxes were supplied by the British Thomson-Houston Co., Ltd.



Map of Bath Tramway System.

The distributing system comprises some 7¾ miles of paper-insulated and lead-covered cables, by the British Insulated & Helsby Cables, Ltd. They are partly laid solid, and partly in porcelain ducts. There are 270 yards of ·2 sq. in., 4,700 yards of ·25 sq. in., and 6,700 yards of ·3 sq. in. section. The return cables have a section of ·6 sq. in., and total up to 1,760 yards. There are over 6,700 yards of three-core, four-core, six-core and seven-core 7/22 pilot wires, and some 8¼ miles of overhead telephone and test wires, all this work being in the hands of Mr. Charles Chadwell.

Of the 30 cars that are so far running, 26 are double-deckers and four single-deck combination cars, all of these being of Milnes construction. There is also one watering car. The double-deckers measure 27 ft. in length over collision fenders, and the single-deckers 28 ft. The trucks are of the Milnes S.B. 60 four-wheel type, the wheel base being 6 ft.; the wheels and axles were supplied by the British Griffin Co. The stairways are of the ordinary pattern, and the Milnes type of life-guard is fitted to each car. The trolleys have swivel heads with graphite bushes, and were made by Messrs. Brecknell, Munro & Rogers. The destination signs are of the British Electric Car Co.'s pattern, and were supplied by Messrs. Milnes. The cars are nicely upholstered, and are lighted both inside and outside. As already mentioned, the British Westinghouse Co. carried out the electrical equipment of the cars, each being fitted

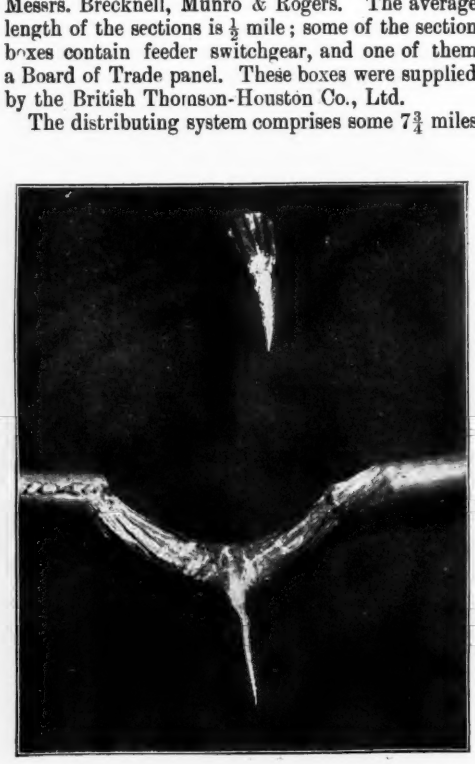
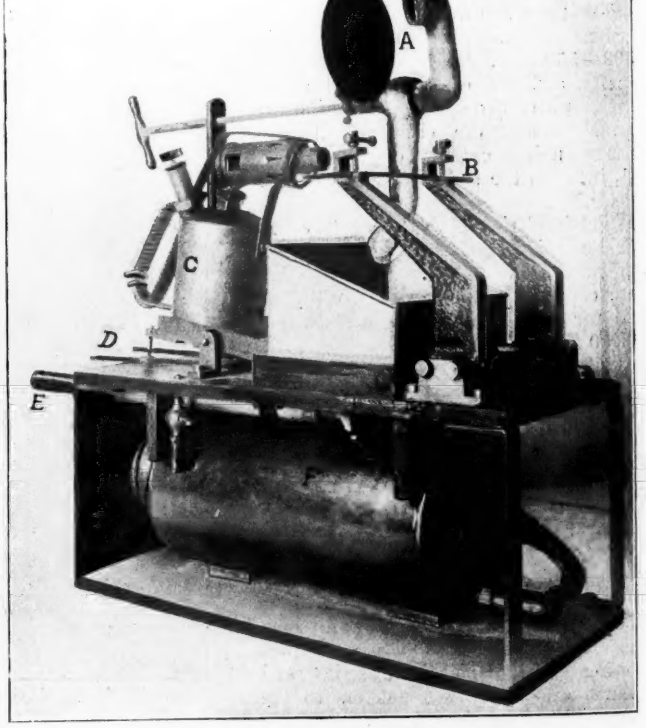


Fig. 2.—Molten Aluminium Supported by a Skin of Aluminium Oxide.



A, Screen; B, Aluminium rods; C, Lamp; D, Levers for applying pressure E, Pump; F, Water reservoir.

Fig. 1.—Cowper-Coles's Machine for Welding Aluminium.

with two 49 B-type 30-H.P. motors and No. 90 controllers, as well as with the British Westinghouse patent magnetic brake. There are also hand brakes.

The severe gradients and curves on the Bath system (the maximum gradient being 1 in 11) have enabled the efficiency of the Westinghouse (Newell) magnetic brake to be demonstrated under the most trying conditions. This brake will, with the controller handle in the braking position, automatically bring the car to rest on the steepest incline should the trolley leave the wire. This fact has been repeatedly demonstrated by removing the trolley from the line on gradients of 1 in 11 and 1 in 12, when the cars were carrying their full complement of passengers, and the cars were brought to a stop in a few yards.

The engineers and the contractors are to be congratulated upon the quick completion of their work; great credit is also due to Mr. R. D. McCarter, who superintended the erection and equipment of the generating station, &c., and successfully inaugurated the traffic.

A NEW PROCESS FOR WELDING ALUMINIUM.

THE Cowper-Coles process for welding aluminium requires no flux, and does not necessitate the hammering of the joint when in the semi-fluid state. The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded, after being faced off square, in a machine (fig. 1, p. 386) fitted with clamping screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers D. The aluminium to be welded is heated by means of an ordinary benzine lamp. As soon as the rods have arrived at the necessary temperature, slight pressure is applied to the levers D, which causes the aluminium rods to unite, and a ring of metal is squeezed out. This ring is largely composed of aluminium oxide, and acts as an insulating and supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle attached to the screen A, which allows water, under pressure, to be projected on to the joint from the reservoir F. The same handle, which turns the water on, places a screen, A, in front of the heating flame; the water pressure is maintained by air supplied by the hand pump E. The rod is finally removed from the machine and the collar filed off, when it will be found that the joint is as strong as the rest of the metal. An oxygen-hydrogen flame or ordinary gas, with or without air, may be substituted for the benzine lamp. The process is a simple one, and can be carried out by any unskilled workman.

Fig. 2 clearly shows the molten aluminium supported by a pipe or case of aluminium oxide, the case having been pricked with a steel point to allow some of the molten metal to flow out.

The following table gives the results of tests of tensile strength on 12 consecutive welds (not picked specimens) made by the process just described. The fractures occurred at a considerable distance from the weld, showing that the metal had not deteriorated at the weld. In the 12 tests referred to, not one specimen broke through the welded portion:—

Dimensions.	Area.	Reduction of area at fracture. Per cent.	Extension. On 4 in. Per cent.	Extension. On 2 in. at fracture. Per cent.	On original area. Elastic limit (yield point) per sq. in.	On original area. Maximum stress per sq. in.		
Diam.	Sq. in.				Lbs.	Tons.	Lbs.	Tons.
0·249 in.	0·0487	7·4	8·0	...	11,491	5·13	20,249	9·04
0·248 in.	0·0483	7·4	13·0	...	8,803	3·93	22,265	9·94
0·254 in.	0·0507	7·5	8·0	...	11,043	4·93	19,868	8·87
0·252 in.	0·0499	7·4	11·7	...	14,358	6·41	16,150	7·21
0·252 in.	0·0499	7·7	13·0	...	21,996	9·82	21,996	9·82
0·250 in.	0·0491	7·6	9·0	...	14,134	6·31	19,622	8·76
0·250 in.	0·0491	7·7	9·0	...	14,134	6·31	14,134	6·31
0·254 in.	0·0507	7·9	11·0	...	15,030	6·71	24,304	10·85
0·251 in.	0·0495	7·8	7·8	...	14,940	6·67	20,361	9·09
0·253 in.	0·0503	7·7	14·0	...	10,236	4·57	19,152	8·55
0·250 in.	0·0491	7·7	9·0	...	12,320	5·50	20,070	8·96
0·247 in.	0·0479	7·7	9·0	...	8,422	3·76	18,704	8·35

Broke outside datum points.

CONTRACTS CLOSED.

(*Continued from page* 382.)

Derby.—The T.C. has accepted the tender of Mr. H. White for the supply of 120 incandescent lamp brackets for the tramway poles at £54, and that of Messrs. J. G. White & Co., Ltd., for lay outs at the tramway car-shed, at £1,360.

East Ham.—The U.D.C. has placed an order with Messrs. Dick, Kerr & Co., Ltd., for 25 arc lamp poles, at £14 19s. 6d. each

Erith.—The British Westinghouse Co. has placed an order with Messrs. Belliss & Morcom, Ltd., for one 720—864-H.P. engine for coupling direct to a Westinghouse 500-KW. three-phase alternator here.

Glasgow.—The Corporation Telephone Committee has accepted an offer amounting to £2,469 of the British Insulated Cable Co. for cable.

Glasgow.—The tender of the Electrical Co., Ltd., for a section of the extension of the Port Dundas generating station has been accepted, for providing and erecting six motor-generators at a cost of £9,958, subject to the condition that the wages paid by the contractors and their sub-contractors to all skilled workmen in the manufacture and erection of the plant will not be less than at the rate of 8½d. per hour, and that, if at any time it is found that this condition is not being observed, the Corporation will be entitled at once to terminate the contract.

Halifax.—The T.C. has given an order to Messrs. Yates and Thom for the supply of two Lancashire boilers for the electricity works, at £1,200.

Islington.—The B.C. has accepted the tenders of Messrs. Rowland Carr & Co., Crompton & Co., A. Round, and the General Electric Co., for supplying arc lamps, columns, carbons, &c., during the ensuing 12 months.

Kingston-on-Thames.—The Board of Guardians has accepted the tender of Messrs. Charles Aldridge & Sons, of London Road, Kingston, for the installation of the electric light at the Infirmary, at £2,074 10s.

Leeds and Wakefield District Tramways.—Messrs. Dick, Kerr & Co., Ltd., have placed the contract for the supply, laying and jointing of the extra high-tension feeders, &c., in connection with the above scheme with Messrs. W. T. Glover and Co., Ltd.

London.—The London County Council, after an hour's discussion at the meeting on Tuesday, decided to accept the tender of J. G. White & Co., amounting to £95,005, for the conversion to the conduit system of the cable tramways between Kennington and Streatham.

The offer of Bolckow, Vaughan & Co. has been accepted by the London County Council for the supply of 538 tons of sole plates at £6 10s. per ton, or a total of £3,497. The plates are required in connection with the track rails being obtained from the same company, for certain sections of the conduit tramways.

Manchester.—The Tramways Committee has accepted the tender of the British Westinghouse Co. for electrical car equipments.

Newcastle-on-Tyne.—The Tramways Committee has accepted the tender of Messrs. Holmes & Co. (£900) for the erection of new switchboards at the City Road power station, to be used in connection with lighting.

Prestwich.—Messrs. Browett, Lindley & Co. have received an order from Messrs. Mather & Platt, Ltd., for the 250-KW. engines for coupling to their dynamo for the Prestwich Asylum.

FORTHCOMING EVENTS.

Friday, March 4th.—At 8 p.m. Junior Institution of Engineers. "Some Practical Notes on Electric Storage Batteries," by Mr. G. C. Allingham.

At 8 p.m. Junior Institution of Engineers. "Notes on Electric Accumulators," by Mr. G. C. Allingham.

Saturday, March 5th.—At 9.30 a.m. Institution of Electrical Engineers (Students). Visit to Messrs. Sir J. I. Thornycroft & Co.'s works, Chiswick.

At 3 p.m. Royal Institution. Lord Rayleigh on "The Life and Work of Stokes." (Lecture III.)

At 7.30 p.m. Glasgow Technical College Scientific Society. "British Competition and Manufacture," by Mr. M. Pickstone.

Monday, March 7th.—At 7.30 p.m. Society of Engineers. Meeting.

At 8 p.m. Society of Arts. "Recent Advances in Electro-Chemistry," by Mr. B. Blount. (Lecture I.)

Tuesday, March 8th.—At 8 p.m. I.E.E. (Glasgow). "Electrical Coal-Cutting Machinery," by Mr. Sam Mavor. Adjourned discussion on "New Methods of Electrical Winding Gear for Collieries and Allied Purposes," by Mr. M. Georgi.

Wednesday, March 9th.—At 8 p.m. Association of Engineers-in-Charge. Mr. W. Crawford on "High Speed Engines."

At 7.30 p.m. North-East Coast Institution of Engineers and Shipbuilders. Adjourned discussion on Mr. B. C. Laws's paper, "Technical Education."

Thursday, March 10th.—At 5 p.m. Royal Institution. Prof. H. L. Callendar on "Electrical Methods of Measuring Temperature." (Lecture III.)

At 7.30 p.m. Institution of Electrical Engineers (Leeds). Mr. H. A. Wraith on "Description of an Electrical Equipment of an Engine Works."

At 8 p.m. Institution of Electrical Engineers at I.C.E. "The Railway Electrification Problem, and its probable Cost for England and Wales," by Mr. F. F. Bennett. "The Rated Speed of Electric Motors as affecting the Type to be Employed," by Mr. H. M. Hobart

At 8 p.m. Liverpool Engineering Society. "Steam Boiler Failures."

Friday, March 11th.—At 8 p.m. Junior Institution of Engineers. Visit to the E.P.S. Co.'s works at Milwall.

At 8 p.m. Physical Society. "The Whirling and Transverse Vibrations of Shafts," by Dr. C. Chree.

At 8 p.m. Institution of Civil Engineers (Students). "The Premium System of Payment for Labour," by Mr. W. G. Banister.

Saturday, March 12th.—At 3 p.m. Royal Institution. Lord Rayleigh on "The Life and Work of Stokes." (Lecture IV.)

At 7.30 p.m. West Hartlepool College Scientific Society. Paper on the "Three-Wire System."

NOTES.

McMillan Memorial Fund.—On inquiry as to the progress of the subscriptions to this fund, we regret to learn that so far it has not come up to the expectations of the Council, doubtless owing to the circumstance that many members of the Institution have not yet forwarded their contributions.

We earnestly appeal to all such members to lose no time in subscribing to the fund. Knowing as we do the deep-rooted regard of the members, individually and collectively, for their late secretary, we feel certain that the inadequacy of the response so far experienced to the appeal for contributions is due rather to inertia than to lack of goodwill; and we sincerely trust that all intending contributors will carry out their intentions without delay. Small donations as well as large will be gratefully welcomed by the Committee in charge of the fund, and the worthiness of its object should render recommendation superfluous.

Legal Query.—We received last week a query relating to the Electric Lighting Acts, which has unfortunately been mislaid. If our correspondent will repeat his question, we hope to deal with it in our next issue.

Patent Litigation.—Patent litigation is always an expensive affair, and often enough a favourable verdict does not adequately compensate. We are glad to note, however, that in the case of the recent actions *re* steam traps, which have been decided in the High Court of Chancery and in the Appeal Court in Mr. Geipel's favour, the result has been a flood of orders, which has rendered it necessary that Messrs. Geipel & Lange shall extend their arrangements for the manufacture of the Geipel traps. Customers are asked to exercise a little forbearance if deliveries should be delayed during the next few weeks.

The Metric System in Parliament.—By the title of this note we do not intend to imply that the measures engaging the attention of our legislators are all to be appraised on the c.g.s. system. Our purpose is to draw attention to the fact that the Weights and Measures (Metric System) Bill passed its second reading in the House of Lords last week, and has been referred to a Select Committee. The almost unanimous opinion of both political parties with regard to the necessity for the compulsory adoption of the system is worthy of note—indeed, the reference of the Bill to a Select Committee called forth some opposition on the score of the delay associated with this procedure. The Bill provides for the compulsory adoption of the system in two years' time. It cannot be denied that many manufacturers are strongly opposed to the change; but the arguments in its favour are very weighty, and we trust that, in spite of the temporary inconvenience which it will entail, the Bill will pass into law at an early date.

New Glow Lamp.—According to *L'Industrie Electrique*, a new glow lamp has been invented by Dr. Just, of Vienna. The filament contains boron, and is said to present no greater difficulties or cost of construction than the ordinary type. The efficiency is very high—a 30-c.p. lamp, at 110 volts, taking 1·7 to 2 watts per candle (Hefner?) and lasting for 250—300 hours. Lamps of 16 c.p. have been made up to 50 volts, and it is hoped that higher voltages will soon be attained.

Appointments Vacant.—The Admiralty is requiring an assistant to the Professor of Technical Electricity and Applied Mechanics at the Gunnery and Torpedo Schools, Portsmouth (£250)—applications to Secretary to Admiralty; electrical engineer for Singapore Municipal Commissioners for three years (£360, £390 and £420); an assistant lecturer and demonstrator in electrical engineering is required for the Birmingham University (£150); assistant electrical engineer for the Blackburn Tramways Department (£150); inspector of overhead equipment for Swansea (£3 3s.); assistant electrical engineer for Leek (30s.).

University College Students' Dinner.—Mr. P. T. J. Estler, 25, Laurence Pountney Lane, Cannon Street, E.C., the hon. secretary of Past Engineering Students University College, London, informs us that the annual dinner of Past Students will be held jointly with that of the Present Students, at the Criterion Restaurant on Friday, March 11th, at 7.30 p.m. Dr. A. B. W. Kennedy, F.R.S., will preside, and will be supported by a number of distinguished engineers and scientists. We understand that these annual dinners have always been a great success, and have been the means of bringing together many old friends who have lost sight of each other. It is hoped that any old students, who have not had notice of the dinner owing to their addresses not being available, will communicate with the hon. secretary at once.

Institute of Marine Engineers.—On 24th ult. Mr. D. K. Roberts read a paper before the Bristol Channel Centre, at Cardiff, on "Electricity on Board Ship."

Rugby Engineering Society.—Mr. B. Hopps was down to read a paper last evening on "Notes on Automobiles."

Northampton Institute.—The distribution of prizes to the successful students at the Northampton Institute, Clerkenwell, was performed by Lord Kelvin, who was accompanied by Lady Kelvin, on Friday last. The various departments were afterwards inspected by many of the large audience that had assembled. On the following evening the Institute was thrown open to the students and friends for the conversazione. The Institute authorities are to be congratulated upon the great success with which Friday evening's proceedings passed off. We do not think there has been a more successful gathering there, unless it be the opening ceremony of a few years ago by the then Lord Mayor. From the few brief remarks made by the Principal, Dr. Mullineux Walmsley, it is clear that the most popular department of the educational side of the Institute is the electrical engineering work. Nearly two-thirds of the class entries are in this department, and in every section this branch is overcrowded, and students have even had to be turned away. Additional accommodation in respect of laboratories, workshops and lecture rooms, is urgently needed. Lord Kelvin's speech was listened to with wrapt attention. In the course of his remarks, the "Noble and Scientific Lord," as one of the members of the Upper House described Lord Kelvin last week—the "Prince of Scientists," as Sir Wm. White addressed him—said that he had seen some of the electrical departments, and had been greatly struck with the splendid arrangements for giving scientific instruction in a practical way to the Institute students. It would be a very great benefit to those who were already entering upon practical work to have the scientific instruction which was daily given there, a good knowledge of which, in all classes of the workers—superintendents, foremen and workmen—was vitally important for the practical success of the work. Lord Kelvin proceeded to make some reference to the remarkable progress which had been made in electrical science during the past 50 years, and said that the work which was now going on in the realm of pure science represented an even greater progress than all that had preceded it. The subsequent speakers were Sir W. H. White and Mr. John Gavey, C.B., who proposed, in most interesting speeches, a vote of thanks to Lord Kelvin, Sir Arthur Rucker, Prof. S. P. Thompson, Prof. Unwin, and Mr. L. B. Sebastian, the chairman of the governing body, who presided over the gathering.

I.E.E. (Glasgow Local Section).—An extraordinary general meeting of this section was held on Saturday, February 13th, at the Heriot-Watt College, Edinburgh. Mr. W. A. Chamen presided. Prior to the meeting, the members of the section paid a visit of inspection to the new works of Messrs. D. Bruce Peebles and Co., Edinburgh, which, in the words of Mr. Chamen, "have facilities for economic manufacture which are scarcely to be surpassed in any way." The committee of the section dined in the evening at the Balmoral Hotel, Edinburgh, at the special invitation of Messrs. Bruce Peebles & Co. The principal business of the meeting at the Heriot-Watt College was a paper by Mr. Georgi on "Electric Winding Engines." On the motion of the chairman, the discussion of the paper was postponed till the next meeting of the section, to be held in Glasgow.

Another Switchboard Fire.—A fire occurred behind the Trafford Park power station switchboard last Friday morning, at 7 o'clock, due to an overheated cable end dropping out of its socket and going to earth on the iron framework. Considerable sparking ensued, and the rubber cables in the vicinity were burnt up, also the wooden platform, before the flames could be got under. A booster was short circuited past immediate redemption, and as the connecting leads to the other booster were burnt up, the machines had to be shut down for an hour or so, and later on supply at 500 volts only between outers was substituted for the usual 250 volts on either side for part of the day. An annoying part of the affair was the fact that fire-resisting cable should have been substituted for the present equipment a short time ago, but other machinery overhauling work had been done by the staff instead. Otherwise the load could have been transferred from the damaged to the sound booster in a fraction of the time that it took to extinguish the flames, and to get fresh cables connected.

The Charing Cross and City Concert.—The annual concert of the staff and friends of the Charing Cross and Strand Electricity Supply Corporation was held on Tuesday evening last at the Grand Hall, Freemason's Tavern, Great Queen Street, W.C. Mr. J. M. Gatti was the chairman.

Scholarships.—The West Riding County Council is offering four technological scholarships (£60 each), of which particulars are given in our advertisement pages to-day.

Paddington Technical Institute. — Last Saturday afternoon Sir Arthur W. Rücker, Principal of the University of London, opened the Paddington Technical Institute of the London County Council at Saltram Crescent.

Royal Institution.—At the Royal Institution on Friday last a lecture was given by Mr. Alexander Siemens on "New Developments in Electric Railways." His remarks were largely devoted to the Marienfelde—Zossen high-speed trials, Italian three-phase railways, and recent single-phase developments.

Souvenir.—We have been favoured with a very acceptable souvenir of last year's International Telegraph Conference which was held in London. It takes the form of a collection of photographs of the gentlemen who represented Great Britain and all other countries concerned at last year's gathering. The photographs have been reduced and artistically arranged on a 21 in. by 27 in. card for framing, by Messrs. Elliot and Fry.

The Royal Society.—The Council of the Royal Society has recommended the following candidates (among others) to the Fellows for election into that society:—

Dr. J. J. Dobbie, director of the Science and Art Museum, Edinburgh; author of papers on the relation between electrical qualities and different kinds of glass, between absorption spectra and the chemical composition of organic compounds, and on various alkaloids.

Dr. A. Muirhead, distinguished as an electrical engineer, especially in submarine cable telegraph work, and as an original investigator in practical questions connected with this subject.

Dr. M. W. Travers, Professor of University College, Bristol, and formerly Assistant Professor to Sir W. Ramsay at University College, London, with whom he was associated in researches at low temperatures and in the discovery of new constituents in the atmosphere, besides independent investigations on similar subjects.

Mr. G. T. Walker, Meteorological Reporter to the Indian Government, and author of papers on aberration and the magnetic field (the Adams Prize Essay, Cambridge) and other electrical subjects, besides a study of boomerangs and a mechanical top.

Personal.—Mr. Herbert Laws Webb has opened an office at 35, Old Queen Street, Westminster, S.W., where he will practice as a general consulting engineer.

Mr. W. L. Winning, of the British Westinghouse Co.'s Erection Department staff, has been appointed as representative for Scotland for the British Electric Plant Co., Ltd., of Alloa.

Mr. Joseph Bastick, who has for many years been associated with calcium carbide manufacture in this country, latterly at Liverpool, is now erecting water power plant for the production of carbide of calcium, at Askeaton, Co. Limerick.

We understand that Mr. Victor H. Coates, M.I.M.E., is retiring from the firm of Victor Coates & Co., Ltd., of Belfast, in order to practice as a consulting engineer. Mr. Coates, who has had 20 years' experience in all departments of the works and offices of his late firm, should be addressed at 32, Ocean Buildings, Belfast.

Mr. B. H. Jenkinson has, for greater convenience in dealing with his consulting electrical practice, taken additional offices at 9, Gray's Inn Square, Holborn, W.C. His local business will continue to be conducted at Crouch End.

Mica.—The chief sources of the mica which is used in the electrical industry at the present time are Canada and Bengal. In the former country the amount exported per year has reached a value of £25,000; and in Bengal some 5,000 persons are engaged in winning and preparing it for market. Mica is a silicate of aluminium and potassium or sodium. Potash-mica is transparent, and its colour is reddish, greenish or grey; presence of magnesium or iron renders it darker. The mineral is also found in China, Siberia, the United States, Peru and Scandinavia.

Insulating Power of Liquids and Semi-Liquids.—An estimate of the insulating capacity of liquid or semi-fluid materials is often required by cable manufacturers and by the makers of oil transformers; but, at the low temperatures which obtain in practice, it is difficult to make the necessary determinations. At Felten and Guilleaume's laboratory, at Carlswerk, it is customary to heat the substance till all moisture has been removed, and then, with the aid of a galvanometer, to make a number of readings of the insulating power at different temperatures. The figures found in this way are plotted in a curve, and serve as data for comparing the value of the various samples tested at the temperatures of observation; while, as a rule, they also enable a sufficiently accurate judgment to be passed on the specific insulating power of the materials at lower temperatures. In his original article, the author gives such a curve, showing the values for linseed oil, "oil," paraffin, wax, asphaltum and resin. (P. Humann, *Elektrotechn. Zeits.*, 1903, xxiv., 1,081.)

An Anti-Friction Metal.—Rieder has described an electrolytic method of making an anti-friction metal, which is suitable for packing or for dynamo brushes. A mould of plaster of Paris is made to conduct by coating it with graphite, and then a layer of copper is deposited on it in an ordinary copper bath, using a copper plate as anode. On this film a second layer of graphite is placed, and upon the graphite a second film of copper, and so on. The presence of the graphite amongst the copper is claimed to reduce friction.

Correspondence.—Owing to pressure upon our space, a number of letters have had to be held over until next week.

THE CENTRAL STATION ENGINEER.

Mr. E. N. Greaves, construction engineer under the Bradford Corporation, who is about to take up a similar appointment with the Council of the City of Birmingham, was on Friday last presented by the staff of the Electricity Department with a handsome dressing-case and a silver match-box. The presentation took place at the generating station, and it was made on behalf of the subscribers by the engineering superintendent (Mr. Wm. Jones), the chair being occupied by Mr. A. S. Blackman, the City electrical engineer and manager. Mr. Blackman said that although he had been at Bradford but a short time, Mr. Greaves had won his esteem and regard.

Holyhead U.D.C. has appointed Mr. Phillip Williams, of Bangor, as electrical engineer, at an annual salary of £140. There were 150 candidates for the post.

Stoke T.C. has appointed Mr. C. H. Thomas as mains foreman.

Mr. Reginald W. Klitz, of the London Electric Supply Corporation, has been appointed mains superintendent in the Electricity Department of the Wimbledon Urban District Council. He will reside at the Electricity Works.

Mr. S. E. Britton, the burgh electrical engineer at Motherwell, has had his salary increased to £300 by the T.C.

Mr. T. Tyson, electrical engineer to the Great Grimsby Street Tramways Co., having resigned his position with the company, the employés presented him with a handsome electro-plated silver tea and coffee service, with suitably inscribed oak tray, as a token of respect. The presentation was made on behalf of the employés by Mr. Samuel E. Barnes, A.I.E.E., senior shift engineer of the company's power station.

NEW COMPANIES REGISTERED.

Dulverton Electric Lighting Co., Ltd. (80,071).—This company has just been registered with a capital of £3,000 in £1 shares, to adopt agreements (1) with G. B. Fisher, and (2) with Messrs. Edwards & Armstrong, and to carry on at Dulverton or elsewhere in Somerset, the business of an electric lighting company in all its branches. The first subscribers are:—J. Moore, The Retreat, Dulverton, gentleman, 25 shares; W. B. Woodbury, Dulverton, hotel proprietor, 5 shares; J. A. Moyle, Dulverton, hotel proprietor, 25 shares; G. B. Fisher, Dulverton, builder, 25 shares; F. W. Wills, 15, Berkeley Square, Clifton, Bristol, architect, 25 shares; B. Bayley, Fore Street, Dulverton, provision merchant, 25 shares; and F. M. Lock, Dulverton, butcher, 50 shares. Minimum cash subscription, £1,000. The first directors are B. Bayley, G. B. Fisher, F. M. Lock, J. A. Moyle, W. B. Woodbury, J. Moore, and F. W. Wills; qualification, £25; remuneration, £10 per annum divisible. Registered office, High Street, Dulverton, Somerset.

Rhodes Electrical Manufacturing Co., Ltd. (80,157).—This company was registered on February 25th, with a capital of £60,000 in £1 shares (2,000 deferred), to acquire the business of electrical manufacturing engineers carried on at Bradford and London as the "Rhodes Electrical Manufacturing Co.," to adopt an agreement with A. L. Rhodes, S. H. Fielder, J. A. Halford, and H. H. Hopkins (trading as the Rhodes Electrical Manufacturing Co.) and to carry on the business of electricians, electrical, mechanical and general engineers, makers of electric tramcars, motor-cars, carriages, cycles, and vehicles, makers of and dealers in electric light cables, telegraph and other wire and accessories, dynamos, motors, telephones, bells, electricians, arc and other lamps, electric light fittings, heating and cooking apparatus, india-rubber, asbestos, and insulating materials, &c. The first subscribers (each with one share) are:—H. Holt, 4, Waldemar Avenue, Ealing, electrical engineer; F. Maddocks, Oakfield, Sheridan Road, Merton Park, Surrey, clerk; T. J. Bootb, 21, Harley Street, Bow, clerk; May W. Vockins, 28, Lavender Sweep, S.W., clerk; F. Hertzberg, Ethelburga House, E.C., secretary; Ethel C. Macdonald, 72, Alexandra Road, Hornsey, N., clerk; and H. H. Hopkins, 28, Canterbury Road, Brixton, S.W., engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £100; remuneration, £75 each per annum and 5 per cent. of the distributed profits, divisible. Registered office, 70, Bishopsgate Street Within, E.C.

Vaughan, Brown & Co., Ltd. (80,142).—This company was registered on February 24th, with a capital of £15,000 in £1 shares (8,000 preference) to acquire the business of electric light, gas, hot water and ventilating engineers and art metal workers, now carried on at 298–300, Goswall Road, London, as Vaughan, Brown & Co., to adopt an agreement with T. W. Vaughan and G. C. Vaughan, and to carry on the said business and that of manufacturers of, and dealers in, motors, batteries, arc and incandescent lamps, electroliers, art metal work, chandeliers, gas, oil and electric light fittings, &c. The first subscribers (each with 100 preference shares) are:—J. S. Shendar, The Chase, Clapham Common, gentleman; H. Marlow, "Glenlea," Westcliff-on-Sea, engineer; A. Balderson, 27, Crofton Park Road, Brockley, accountant; E. I. P. de Larcque, Sussex House, Leadenhall Street, E.C., chemical broker; T. W. Vaughan, 298 and 300, Goswell Road, E.C., engineer; E. S. Fergusson, 16, Seymour Place, Portman Square, W., mineral agent; J. W. Hyde, 23, Park Road, Regent's Park, N.W., director; and F. S. Guy, Clarence House, Pellatt Grove, Wood Green, N.E., engineer. No initial public issue. The number of directors is not to be less than two nor more than six; the subscribers are to appoint the first.

Cleminson Electric Lamp Attachment, Ltd. (80,145).—This company was registered on February 25th, with a capital of £2,500 in £1 shares, to adopt an agreement with N. Cleminson, and to carry on the business of electric light engineers, electricians, contractors, architects, ironmongers, manufacturers of, agents for and dealers in electrical, telegraph, telephone and traction supplies and appliances, manufacturers of switchboards, switches, cables, wires and electrical plant, instruments and appliances, &c. The first subscribers (each with one share) are:—D. E. Anderson Restenneth, W. Didsbury, merchant; J. Allan, 55, Northern Grove, West Didsbury, technical chemist; F. W. Saberton, 10, Stockport Road, Manchester, surgeon; F. V. Smethurst, 8, King Street, Manchester, tailor; W. M. Jaffrey "Newstead," Wilmslow, bank manager; N. Cleminson, 53, Cheetham Street, Lower Broughton, agent; and F. K. Macmorran, Hopefield, Victoria Park, Manchester, bank manager. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. Allan, D. E. Anderson and F. K. Macmorran; qualification, 25 ordinary shares; remuneration, £100 per annum divisible. Registered office, 19 and 20, York Chambers, 27, Brazennose Street, Manchester.

Fulham Electric Joinery Works, Ltd. (80,148).—This company was registered on February 25th, with a capital of £2,000 in £1 shares, to carry on the business of joinery manufacturers, timber merchants, builders, contractors, &c. The first subscribers are:—E. A. Gale, 40, Clarendon Road, Putney, S.W., builder, 198 shares; F. Bastable, 3, Disraeli Road, Putney, S.W., builder, 199 shares; A. J. Easton, 27, Fulham Palace Road, S.W., builder, 199 shares; A. S. de Vinny, 43, Waldemar Avenue, Fulham, S.W., clerk, 1 share; Mrs. W. S. B. Gale, 40, Clarendon Road, Putney, S.W., 1 share; T. D. Chandler, 13, Fish Street Hill, E.C., timber merchant, 1 share; and J. P. Burr, 27, Richford Street, Hammersmith, W., traveller, 1 share. No initial public issue. The number of directors is not to be less than two nor more than five; the first are G. A. Gale, F. Bastable and A. J. Easton; qualification, £100; remuneration as fixed by the company. Registered office, 554, Fulham Road, S.W.

Applegarth & Ostlere, Ltd. (80,055).—This company was registered on February 16th, with a capital of £4,000 in £1 shares, to acquire the business carried on in the City of London as "R. Applegarth" and the "Simplex Appliance Syndicate," to adopt an agreement between R. Applegarth of the one part, and A. Ostlere (for this company) of the other part, and to carry on the business of submarine, mechanical and electrical engineers, manufacturers and patentees of and dealers in smoke-preventing appliances, diving apparatus and other articles. The first subscribers (each with one share) are:—R. Applegarth, 11, Queen Victoria Street, E.C., engineer; A. Ostlere, 14, Queen Victoria Street, E.C., engineer; G. T. Harrap, 5, Budge Row, E.C., consulting engineer; M. Belsham, 52, Queen Victoria Street, E.C., engineer; J. T. Corbin, 52, Queen Victoria Street, E.C., engineer; J. C. Keeney, 1, Falmouth Road, S.E., engineer; and T. Baillie, 49, Barrington Road, Brixton, S.W., engineer. No initial public issue. The first directors are R. Applegarth and A. Ostlere (both permanent). Registered office, 11, Queen Victoria Street, E.C.

Tramways Extension Syndicate, Ltd. (80,128).—This company was registered on February 23rd, with a capital of £5,000 in £1 shares, to acquire or construct and work (by electricity, steam, horse or power) tramways, railways, &c. The first subscribers (each with one share) are:—J. W. Hain, Inganess, Chingford, secretary; W. Goldie, 29-30, Broad Street Avenue, E.C., secretary; C. F. Lupson, 272, Upland Road, S.E., assistant registrar; S. E. Nettleton, 24, Earlham Grove, Forest Gate, E., accountant; W. B. Wingate, 105, St. Paul's Road, Kennington, S.E., secretary; C. F. Bell, 9, Edith Road, Selhurst, S.E., accountant; and C. S. Mats, 29, Broad Street Avenue, E.C., registrar. No initial public issue. The subscribers are to appoint the first directors.

Rhodes Electrical (Parent) Syndicate, Ltd. (80,158).—This company was registered on February 25th, with a capital of £5,000, in 4,925 shares of £1 each, and 1,500 deferred shares of 1s. each, to carry on the business of electricians, electric and general engineers, electric tram car and motor car manufacturers, manufacturers of electrical cables, wires, accessories, and fittings, &c. The first subscribers (each with one share) are:—H. Holt, 4, Waldemar Avenue, Ealing, electrical engineer; F. Maddocks, Oakfields, Sheridan Road, Merton Park, Surrey, clerk; T. J. Booth, 24, Harley Street, Bow, clerk; May W. Vockins, 28, Lavender Sweep, S.W., clerk; F. Hertzberg, Ethelburga House, E.C., secretary; Ethel C. McDonald, 77, Alexandra Road, Hornsey, N., clerk; and Hilda M. Dodson, 37, Chetwynd Road, N.W., clerk. No initial public issue. The subscribers are to appoint the first directors; qualification, except first directors, £50. Registered office, 70, Bishopsgate Street Within, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Derbyshire and Nottinghamshire Electric Power Syndicate, Ltd. (69,618).—A 5 per cent. debenture, dated January 20th, 1904, to secure £15,000, has been registered. Property charged (as a floating security): The company's undertaking and property, present and future, including uncalled capital. Holders: Nottingham and Nottinghamshire Banking Co., Ltd., Thurland Street, Nottingham. This debenture is in substitution for a security dated March 19th, 1902, given to same holders, and covering £9,000 and interest.

Adams-Randall Telephone Patents Co., Ltd. (61,457).—Issue, on February 5th, of a £50 debenture, part of series created April 22nd, 1899, to secure £40,000, charged on the company's patents, patent rights and leasehold premises. Trustees: D. Davies, 95—7, Finsbury Pavement, E.C. Previously issued of same series: £9,950.

Julius Sax & Co., Ltd., (63,371).—Issue, on February 11th, of £1,200 debentures, part of series created January 30th, 1904, to secure £1,600, charged on the undertaking and property, present and future. No trustees. No previous issue of same series.

Porous Accumulator Co., Ltd. (57,526).—This company's annual return was filed on December 31st, when the entire capital of £3,000 in £1 shares had been taken up. £1 per share has been called up and paid on 1,007 shares, and 1,993 are considered as fully paid. Mortgages and charges: £16,000.

Nernst Electric Light Co., Ltd. (60,807).—This company's annual return was filed on January 28th, when 139,480 preference and 180,000 ordinary shares had been taken up out of a nominal capital of £320,000 in 140,000 preference and 180,000 ordinary shares of £1 each. £1 per share has been called up on 114,480 shares, resulting in the receipt of £114,480, in addition to £298 15s. paid on 520 forfeited shares. Mortgages and charges: Nil.

Roundhay and District Electric Lighting Co., Ltd. (66,293).—This company's annual return was filed on January 6th, when 777 shares had been taken up out of a nominal capital of £20,000 in £10 shares. £7 per share has been called up, resulting in the receipt of £5,274. £165 remains in arrears. Mortgages and charges: Nil.

Sunbeam Lamp Co., Ltd. (25,498).—Issue, on February 12th of £8,200 debentures, part of series created January 28th, 1904, to secure £10,000, charged on the company's undertaking and property, present and future, except uncalled capital. No trustees. No previous issue of same series.

National Electric Engineering Co., Ltd. (41,619).—This company's annual return was filed on December 31st, when 2,669 shares had been taken up out of a nominal capital of £5,000 in £1 shares. £1 per share has been called up and paid on 654 shares, and 2,005 are considered as fully paid. Mortgages and charges: Nil.

Pyke, Harris & Co., Ltd. (37,947).—This company's annual return was filed on January 14th, when 1,218 "A" and 1,440 "B" shares had been taken up out of a nominal capital of £30,000 in 1,400 "A" and 4,600 "B" shares of £5 each. £5 per share has been called up on the "A" shares, resulting in the receipt of £6,090. £7,200 is considered as paid on the "B" shares. Mortgages and charges: Nil.

British Electric Light Wiring Co., Ltd. (58,013).—This company's annual return was filed on December 24th, when 156 shares had been taken up out of a nominal capital of £10,000 in £1 shares. 10s. per share has been called up on 7, and £1 per share on 149 shares, resulting in the receipt of £152 10s. No mortgages or charges.

Electric Sign and General Advertising Co., Ltd. (45,610).—This company's annual return was filed on January 21st, when 2,000 shares had been taken up out of a nominal capital of £5,000 in £1 shares. £1 per share has been called up and paid on 1,000, and the remaining 1,000 shares are considered as fully paid. No mortgages or charges.

Great Western Electric Light and Power Co., Ltd. (41,488).—This company's annual return was filed on December 30th, when 7 shares had been taken up out of a nominal capital of £1,000 in £10 shares. No calls have been made. No mortgages or charges.

ELECTRICITY SUPPLY ACCOUNTS.

Ilford Municipal Electrical Supply.

We give herewith the returns for the second 12 months' working of the Ilford electrical undertaking. During the year a traction supply was inaugurated, but owing to its only covering a small portion of the year, it had no appreciable effect on the results. The year's working produced a gross profit of £5,341, and after meeting financial charges, covering the previous year's deficit and providing for bad debts, a small deficit was carried forward.

The charges are:—For private lighting on the maximum demand system, 8d. and 2d., or a flat rate of 5d. per B.T.U.; power 7d. and 1d. per unit, maximum demand, or flat rate of 3d. to 1¾d. per unit. The borough electrical engineer is Mr. A. H. Shaw.

General Statement.

For year ending March 31st—	1903.	1902.
Total capital expended	£75,298	£57,555
Number of units sold—		
Private supply	411,643	156,484
Public lighting	337,932	246,660
Traction	22,613	—
Total number of units sold	772,188	403,144
Equivalent No. of 8-c.p. lamps connected	47,640	25,900
Number of public lamps	44 arc 807 inc.	44 arc 600 inc.
Maximum load in kw.	805	343
Revenue account—		
Gross revenue	£12,068	£5,517
„ expenditure	£6,727	£4,104
„ profit	£5,341	£1,413
Average price obtained—		
Private lighting	4·56d.	4·65d.
Public lighting	2·62d.	2·52d.
Traction	2·23d.	—

Revenue Account for Year Ending March 31st, 1903.

Gross revenue	£12,068 = 3·76d. per unit.
Works and distribution costs (inc. pub. ltg.)	£4,921 = 1·53d. „
Total works costs	£6,727 = 2·09d. „

Profit Statement.

Interest on loans, &c.	£2,301
Sinking fund	1,605
To bad debts	150
To last year's deficit	1,411
To balance carried forward	−126
Gross profit	£5,341

Walsall Municipal Electrical Supply.

The Walsall undertaking has shown signs of substantial improvement during the past year. The output, with the help of a traction supply, has increased by 40 per cent. Works costs are reduced by ¼d. per unit, and the gross profit was sufficient to meet financial charges and the deficit of 1902, leaving a balance in hand of £70.

The prices for energy were:—Private lighting, 6d. and 2d. power 2½d. and 1d., on the maximum demand system with discounts; public arc lamps £21 10s. per annum. The city electrical engineer is Mr. A. Wyllie.

General Statement.

For year ending Dec. 31st—	1903.	1902.
Total capital expended	£78,572	£56,541
Number of units sold—		
Private supply (and traction, 1903) ...	593,121	415,076
Public lighting	29,708	29,280
Total number of units sold	622,829	444,356
Equivalent No. of 8-c.p. lamps connected	34,535	29,938
Number of public lamps	19	19
Maximum load in kw.	521	442
Revenue account—		
Gross revenue	£8,384	£6,830
„ expenditure	£5,498	£4,410
„ profit	£2,886	£2,420
Average price obtained per unit—		
Private lighting	3·93d.	3·51d.
Public lighting	4·00d.	4·00d.
Traction	1·92d.	—

Revenue Account for Year ending Dec., 1903.

Gross revenue	£8,384 = 3·22d. per unit.
Works and distribution costs (inc. pub. ltg.)	£4,285 = 1·65d. „
Total works costs	£5,498 = 2·12d. „

Profit Statement.

Interest on loans	£1,458
Sinking fund	1,114
To debit balance brought forward from 1902 ...	244
To balance carried forward	70
Gross profit	£2,886

CITY NOTES.

Blackheath and Greenwich District Electric Light Co.

Sir J. A. Willox, M.P., presided at the annual meeting held on Friday last at Winchester House. In moving the adoption of the report (Electrical Review, Feb. 19, 1904), he addressed the shareholders at considerable length, there being several matters calling for detailed explanation, particularly the proposed purchase of the Crystal Palace undertaking. He said that the company was making steady and continuous progress. The number of lamps connected during the year was the largest they had had, namely, 15,624, bringing up the total to 60,540 lamps. Since the end of the year the progress had continued unchecked; indeed, the ratio of new business was better than at the corresponding date last year. In the four years that the company had been at work the gross profits had

been £144, £2,150, £7,355, and £11,041. To meet the constantly developing progress of the business, it had been necessary to incur additional capital expenditure, and although this new capital had been raised under somewhat onerous conditions, it had not crippled the resources of the company. All the extra expenditure incurred had yielded a profitable return. After meeting all charges, there was a net profit in 1902 of £2,909. For 1903 the clear surplus had risen to £8,001. The board had commenced a substantial depreciation fund. Last year they set aside £1,000 for depreciation; this year they had increased the amount to £1,250, and they had also written off £1,185 from preliminary expenses. After making liberal, and perhaps rather conservative, provisions, and after providing for debenture and preference interest, they had a clear surplus of £5,219. The question the directors had to consider was what they should do with it. The first prompting was to distribute it among the shareholders as dividend. They might have declared a dividend of 3 or 4 per cent. for the year, and, being large shareholders, their natural bias was in this direction, but upon full consideration they had come to the conclusion that in the permanent interests of the company it would not be judicious to pay a dividend this year. The exercise of a little more patience and forbearance would operate to the ultimate prosperity of the business, and place it on a more assured basis of soundness and stability. They had taken counsel with men of great experience in financial and electrical affairs, and their recommendation was emphatic that at present the company should keep its available resources well in hand. At present the money market was in a very disturbed state, and as the company was under the necessity of raising additional capital, those experts had said that the facilities for raising the new capital would be greatly improved by husbanding the resources for the present. The declaration of a dividend was postponed for, he hoped, only a short time longer. Even if they did not get an immediate dividend, they consolidated the position of the company and improved the value of the shares. The company promoted a Bill in the last Session of Parliament to acquire the Lewisham and Penge undertakings, and to purchase the undertaking of the Crystal Palace Electric Light Co. That Bill received the approval of the local authorities, and was passed by Parliament. The Lewisham and Penge districts could be worked economically and efficiently by this company. The transfer took place on September 30th last, but before all the legal formalities were completed the work of supplying Lewisham was commenced. A profit of £1,185 was realised on the work done for the Lewisham Co., but as this was an exceptional item of income, it was not brought into the revenue account, but was applied in reduction of preliminary expenses. A considerable network of mains had already been laid down in Lewisham, and the results were eminently satisfactory. There was a large and growing demand for current, and Lewisham promised to be a lucrative field of operations, because it could be supplied without additional expenditure on generating plant. They had been at work in Lewisham for only a short time, but the results fully confirmed the anticipation of the board that it would yield a profitable return. They had not yet begun operations in Penge. In regard to the Crystal Palace Co., the Bill received the Royal Assent on August 11th, and Parliament having sanctioned the arrangement, it became possible to enter into negotiations for the acquisition of the undertaking. There were special reasons why it was desirable that the Crystal Palace Co.'s undertaking should be acquired by this company, because it could be worked advantageously and profitably, and also because it could be unified into this company's system. In fact, it was the natural complement of their whole scheme, and dovetailed into it most conveniently. The Crystal Palace area formed a connecting link between the separate areas of supply authorised by the Lewisham and Penge Orders. The managing director was satisfied that the undertaking could be worked economically in conjunction with the present system. Protracted negotiations ensued, with the result that a provisional agreement had been entered into for the purchase of the whole undertaking of the Crystal Palace Co., including generating stations, mains, &c., for the sum of £67,500, payable in instalments. The total expenditure on capital account, as shown in the last report of the Crystal Palace Co. to December 31st, 1903, was £121,408, so that this company would buy the concern for little more than half the original cost. The local authorities and the Board of Trade have approved of the change of system from direct to alternating current. The sanction of the Board of Trade had to be given to the proposed purchase, but no difficulty was likely to arise on that score, as the Board of Trade had already approved in an informal way. The directors recommended the proprietors of the Blackheath Co. to ratify the provisional agreement. The business, even under present conditions, would yield a fair return on the reduced capital, and the economies and developments which might be effected were calculated to increase that return, and give the Blackheath Co. an immediate profit. The purchase will not be a drag on the resources of the Blackheath Co. As the instalments of payment fell due, the growing revenue would cover the new obligations, and the ultimate result would be an assured profit. The company's area of supply would be greatly enlarged and consolidated, and they would have one of the largest and most hopeful districts in London. The two generating stations were very conveniently located for the service of the district—one at each margin. Regarding the financial situation, means must be provided to meet the present and prospective requirements of the company. As the proprietors were aware, there had been issued £100,000 mortgage debenture stock, the holders of which had a right in 1905 to convert into preference shares. The directors proposed to ask the debenture holders to agree to a modification of their rights, either by converting their present stock into preference shares at once, or by accepting an equivalent amount in a new debenture issue, at 4½ per cent. per annum, without any future right to convert into preference shares. If the debenture shareholders agreed to this proposal, the position of the company would be greatly simplified. It would not augment the amount of the 7 per cent. preference stock already authorised, which was only issued under the pressure of extreme necessity. It would also clear the ground for the issue of a new debenture stock in lieu of the existing stock, which would not carry with it any privilege to convert into preference or ordinary shares. Of course, the scheme depended on the acquiescence of the debenture-holders; nothing could be done without their consent; but the directors thought that fair and reasonable terms could be arranged. At present it was impossible to say what terms might be finally settled. The directors asked, by special resolution, to entrust them with power to negotiate with the debenture holders, and to arrange such terms of settlement as might be found practicable.

Mr. H. St. John Winkworth seconded the adoption of the report, which, after a few remarks had been offered by shareholders, was carried unanimously. The retiring directors and auditors were re-elected, and a vote of thanks was accorded to Mr. Bowden, the managing director, and the other directors.

The extraordinary general meeting was then held.

The Chairman moved the following resolution:—

(1) That the agreements made the 26th day of September, 1903, and the 15th day of December, 1903 (subject to such further modification, if any, as the directors may deem expedient or find necessary), between the Crystal Palace District Electric Supply Co., Ltd., of the first part, Gordon Blennerhassett Voules & John Irving Courtenay of the second part, the Electric Construction Co., Ltd., of the third part, and the company of the fourth part, relating to the purchase by the company of the whole undertaking and assets of the said Crystal Palace District Electric Supply Co., Ltd., be and are hereby confirmed.

This was seconded by Mr. Bowden, who explained that, in changing over from one system to the other, it was proposed to use the Crystal Palace station as a peak station only. The purchase price was £68,000, and they estimated that the capital outlay to put the system over would be about £30,000. The gross revenue of the Crystal Palace Co. for 1903 was £9,001, and the net revenue £2,129. He estimated that immediately the change-over was effected the gross revenue would be largely increased and the costs considerably reduced, as they would be able to dispense with the working shifts during the daytime and during the evening after the third shift. They estimated the revenue at £10,000, and he thought that they ought to be able to reduce the costs very shortly to £5,000, and even less, leaving a balance of £5,000. Supply would, of course, be two-phase 3,000 volts, reduced to 200 and 100 volts on the low-tension network.

The resolution was carried unanimously.

The Chairman then moved:—

(2) That the directors may from time to time accelerate, extend, postpone or vary the option of the debenture stockholders of the company to exchange their debenture stock for preference shares of the company on such terms and in such manner as they may determine, or may give or provide out of the funds of the company such consideration for the release or surrender of such option as they may deem expedient, and arrange with the debenture stockholders.

After explaining the proposal at some length, it was seconded by Mr. Winkworth.

A Shareholder asked whether they were going to leave the ordinary and preference capital exactly as now, and the reply was in the affirmative. The new debentures would be quite sufficient to meet the purchase and extensions expenditure. Those who took the new debentures would get a bonus in the form of a premium for extinguishing their existing right to convert. It would be an option in stock, not in cash.

The resolution was carried.

Blackpool and Fleetwood Tramways Co.

This company's half-yearly meeting was held last week in Manchester.

Mr. George Richardson, who presided, reported that for the half-year ending December 31st, 1903, there was a balance of profit, after providing for debenture interest, of £10,677 10s. 8d. A dividend at the rate of 9 per cent. was recommended. This absorbed £6,750, and it was decided to appropriate £1,500 to depreciation account, and £500 to general reserve, leaving a balance of £1,927 10s. 8d. to be carried forward. During the half-year the company has carried 1,469,964 passengers, and the gross receipts from all sources amounted to £21,404 8s. 5d. The report was unanimously adopted, and the retiring directors, Messrs. Richardson and Prestwich, were re-elected.

Northwich Electric Supply Co.

The annual meeting was held at the offices, Northwich, on Wednesday last week. Mr. J. A. Sauer, who presided, in moving the adoption of the report, said that the company was to be congratulated on the present condition of its property. The number of consumers and the number of units consumed had increased, while the working expenses per unit had decreased. The policy of supplying power at a low figure had been amply justified, as the increase from that source had been more than double the increase in working expenses, so far as generation expenses were concerned. The directors did not fear any competition in the district, as the price charged was probably lower than any new company would be able to charge—at any rate, for some years. During the year a second cable had been connected across the river at Navigation Bridge, and coupled up to the Leftwich main. At the present price, there were very few, if any, trades in the town which would not find it pay to throw out their old engines and boilers, and put down electric motors.

The report was adopted, and a dividend of 3 per cent. was declared.

The Mackay Cable Companies.

A Reuter dispatch from New York says that Mr. Clarence H. Mackay, president of the Commercial Cable Co., has addressed a circular letter to the stockholders of that company, inviting the deposit of their stock for exchange for shares in a trusteeship, created under the laws of Massachusetts, under the name of "The Mackay Companies." The capitalisation of the Commercial Cable Co., which also owns the Postal Telegraph Cable Co., is $15,000,000 (£3,000,000), upon which 8 per cent. dividends are paid. The "Mackay Companies" has authorised for exchange for this stock, $30,000,000 (£6,000,000) par value of its own 4 per cent. cumulative preferred shares, and a like amount of common shares, so that each stockholder in the Commercial Cable Co. will receive for his holdings 200 per cent. of that holding in the preferred, and 200 per cent. in the common shares of the new concern. The "Mackay Companies" is an investment trust designed by Mr. Mackay to perpetuate the name of his father, to provide for the development of the companies which he founded, and to safeguard, upon an even basis with his own, the interests of those who have invested capital in the enterprises with which John W. Mackay was most conspicuously identified. The plan is practically an accomplished fact.

Cambridge Electric Supply Co.

Mr. D. Munsey presided at the annual meeting of this company of 24th ult.

In moving the adoption of the report (see Electrical Review, February 19th) the Chairman said that the money used upon the extensions during the year was raised by an overdraft at the bank, for which on £10,000 they paid 4 per cent., and beyond that sum at 4½ per cent. The directors now proposed to call up £1 a share, and so raise £9,400 to help pay off what was thus owing. They would also issue £30,000 4½ per cent. debentures, of which only £15,000 might be called up during the year. They had spent something like £1,100 or £1,200 upon coal; that was a very satisfactory item, because, although the company had supplied some 40,000 units more during the past year, the coal consumption had been very little more than it was during the previous year. They had made arrangements to place £1,500 out of the profits of the year to depreciation. The chairman made reference to an item which he stated was interest on workmen's deferred pay. He explained that the directors liked to encourage workmen to make provision for the future, and accordingly the company took care of some of their weekly earnings, upon which the men were paid 5 per cent. With reference to a reduction in the price of current, the directors had come to a decision that at the summer quarter the consumers who now paid 7d. per unit should have the price reduced to 6d. He thought they could do this, and at the same time see their way clear to maintain their dividend.

The report was adopted.

Dr. Latham moved that a dividend at the rate of 7 per cent. be paid for the year. This was agreed to.

Mr. Swinton alluded to the subject of the electrification of the Cambridge tramways. He mentioned that a proposal to electrify them was made a few years ago, when the British Electric Traction Co. made arrangements for taking over the horse tramways for the purpose of running them by electricity. At that time the Cambridge Electric Supply Co. made an agreement with the British Electric Traction Co. to supply all the electricity. Such an arrangement was advisable from the point of view of the Cambridge Electric Co., as the income to be derived through it would probably amount to £2,000 a year. That was all some years ago, and the British Electric Traction Co. were apparently doing nothing in the matter. The directors had thought well to take over from them on behalf of the company the agreement that the British Electric Traction Co. had entered into with the Cambridge Tramways Co., with a view to pushing matters on a little faster. He was not able to say any more at present, because that was as far as the matter had gone.

The remuneration of the directors was increased from 200 to 300 guineas.

Newcastle-upon-Tyne Electric Supply Co.

The annual meeting was held at Newcastle, on 25th ult., Dr. J. T. Merz presiding. In moving the adoption of the report, which was abstracted in our last issue, he said that the operations of the company had been considerably increased. The units sold amounted to 9,033,625, as against 5,537,500, showing an increase of 3,496,125. There was a considerable difference in the way these units were sold and distributed to consumers. In the year before, more than half the units were sold wholesale. Last year they took over the business of Walker and Wallsend Gas Co., and became not only sellers but also distributors of these units. They had also to bear the cost of distribution as well as manufacturing. This was considerable. This difference of proportion between wholesale units and units distributed by them had had the effect of putting up the cost per unit delivered, but if they rectified the figures and added on the rentals the price came out really the same as the year before. The gross profit of the company for the year was £42,567, against £26,522 the year before. In former years they had to report considerable increase in the length of cables and wires. This year he had to report a very small addition to that. This was significant. The reason of the small increase was that they had now entered into a different stage of their business. Whereas two years before they had very much increased, last year they had increased very little, but they had begun really to do more profitable work, that was, to fill up the line, and get as many customers as they could. The company had now acquired an interest in the Priestman Power Co., Ltd. The reason why they had joined hands with this company was this. At first, the company limited its operations to Newcastle, but had not lost sight of the fact that this company wanted to extend its operations over Northumberland and Durham. The fact that a considerable source of power existed in the form of waste heat of gases at these coke-ovens gave an opportunity for considering the propriety of utilising these for electric purposes; and the owners of the Priestman Co., being shareholders, an understanding was come to to join hands, they giving heat and gas, and the company, on the other hand supplying electrical knowledge, connections, and facilities in order to utilise these. They would all be aware that the Corporation of Newcastle had brought in a Bill for the extension of their tramways in the districts outside the borough. These districts, or some of them, were in the area of this company, in which the company had a kind of monopoly for the supply of electricity. They would also remember that the company were not able to maintain what they considered their rights with the Corporation when the Corporation started their tramways. The company then thought they had a right to supply electricity for all purposes within the borough, but as tramways were not mentioned, and as nobody thought then of working tramways by electricity, it was decided the Corporation had the right, in spite of this company's provisional order, to supply from their own power house, and the supply of power was taken away from the company. If the Corporation got this Bill for extending their tramways into the areas in which the company had these rights they would be in a similar position again. Therefore, in order to guard their rights and protect them, the directors had thought it necessary to lodge a petition against this Bill.

The report was adopted.

Dividend of 5 per cent. on the preference, and 8 per cent. on the ordinary shares, were declared.

Brompton and Kensington Electricity Supply Co.

The annual report for 1903 says that the revenue account shows a credit balance of £29,234, which, with the balance of £889 brought forward, and £335 balance of interest received, makes a total of £30,458. After deducting £2,424 for interim dividend on the 7 per cent. cumulative preference shares, and £5,881 11s. 10d. interim dividend at the rate of 9 per cent. per annum for the half-year to June 30th on the ordinary shares, the directors recommend that the sum remaining—viz., £22,152—be dealt with as follows:—

To credit of depreciation account	£7,500
To payment of dividend on the preference shares for half-year ended December 31st	2,308
To payment of dividend on the ordinary shares for half-year ended December 31st at the rate of 11 per cent. per annum, making 10 per cent. for the year	7,358
To directors' additional remuneration	807
Leaving, to be carried forward, a balance of	4,179
Total	£22,152

In view of the large sums, amounting to upwards of £10,000 which the board has in the past waived out of its ordinary fees, and of the fact that the shareholders are now receiving a substantial revenue from the undertaking, the directors feel that the proposed additional directors' remuneration will meet with approval.

The following table shows the progress of the company's business during the past four years:—

Year.	Equivalent of 35-watt (8-c.p.) lamps connected.	Increase in 35-watt (8-c.p.) lamps.	No. of customers connected.	Gross receipts.	Expenditure.	Net receipts.
1900	108,978	13,675	2,395	£36,125 4 5	£14,801 0 10	£21,324 3 7
1901	121,212	12,234	2,650	41,154 4 6	16,905 2 8	24,249 1 10
1902	137,326	16,114	2,979	45,655 2 7	19,036 4 8	26,618 17 11
1903	154,853	17,527	3,326	50,272 18 7	21,089 0 6	29,233 18 1

London Electric Supply Corporation.

The directors' report for the year 1903 shows that the profit on the working for the year is £36,178, to which has to be added interest on deposit and amount brought forward, £1,576, making a total of £37,754. Out of this the interest to December 31st, viz., £14,816 has been paid, leaving a balance of £22,938.

The board propose to deal with this amount as follows:—

Dividend of 6 per cent. (or 6s. per share) on the preference shares for the year, of which an interim dividend of 3s. per share was paid on September 1st	£14,952
To reserve account	6,000
To carry forward	1,986
	£22,938

The supply of current has been efficiently maintained during the year, and the cost of production still further reduced. The number of lamps has been increased during the year by 9 per cent., or the equivalent of 17,577 lamps of 8 c.p. The capital expenditure for the year was £36,198, necessitated by the expansion of the company's lighting business, and the contract with the London County Council to supply power to their tramways in South London. This power supply commenced on January 17th, and is tending, as expected, to reduce the average cost of generation. The company is now approaching the limits of the capital powers created in 1888. The directors recommend the creation of 20,000 more preference shares, and a resolution will be proposed at the meeting to that effect. The plant and machinery have been maintained out of revenue, and are in efficient condition. Sir William Pollitt and Mr. Robert D. Norton have been elected additional directors on the board.

City of London Electric Lighting Co.

The directors' report for the year shows that the expenditure on capital account amounted to £81,030.

The total revenue for the year, £242,102, including interest on deposits, investments, &c., £784, was		£242,886
From which must be deducted the following items:—		
Expenses of generation and distribution	£55,699	
Repairs and maintenance of buildings, machinery, plant, mains and other works	15,948	
Rent, rates, taxes, general and special charges	36,888	
	£108,485	
Interest transferred to debenture stock premium redemption fund	1,192	
Staff superannuation fund..	289	
		109,966
Leaving		£132,920
Balance brought forward from 1902		22,619
Making a total available revenue of ..		£155,539
Of this sum the following amounts have been distributed or provided for:—		
(*a*) Interest on first and second debenture stock for year ended December 31st, 1903	£31,825	
(*b*) Transfer to reserve account	45,000	
,, for leasehold redemption	500	
		77,325
Leaving for dividends on preference and ordinary shares and for "carry forward" to 1904		£78,214

The directors now recommend that the following dividends for the year ended December 31st, 1903, be declared:—

Preference Shares Nos. 1 to 40,000.—12s. per share (6 per cent. for the year). Of this sum 6s. per share was paid on July 15th leaving 6s. per share for present distribution. ..		£11,360
Ordinary Shares.—10s. per share (5 per cent. for the year). Of this sum 5s. per share was paid on July 15th .. .. leaving 5s. per share for present distribution.		16,693
Dividends on account already distributed		£28,043
To be distributed as above—		
(*a*) 6s. per share on 40,000 preference shares, less tax	£11,450	
(*b*) 5s. per share on 70,595 ordinary shares, less tax ..	16,840	
		28,290
Total dividends for year		£56,333
Carried forward to 1904		21,882
		£78,215

Warrants for the alance of dividends will be posted on March 9th.

Private Supply: Average Prices Per Unit Obtained.

1897.	1898.	1899.	1900.	1901.	1902.	1903.
7·30d.	6·22d.	5·16d.	4·09d.	4·54d.	4·04d.	3·72d.

The following comparative statements show the position of the company as it was at the end of 1896 and at subsequent periods:—

Private Supply: Number of Customers and Lamps Connected.

December 31st ..	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
Number of customers being supplied ..	5,803	6,322	7,414	8,788	9,855	10,618	10,988	11,197
Number (equivalent) of 8-c.p. lamps connected.	247,785	296,012	355,825	429,628	511,118	549,177	574,115	640,625

On February 10th, 1904, there were 700,766 8-c.p. lamps (equivalent) applied for, out of which 661,195 were connected, and the customers numbered 11,255.

The B.O.T. units sold during the year 1903, excluding public supply, were 13,596,075, as compared with 12,988,615 in 1902, and 11,526,951 in 1901.

Statement of Income as shown in the Audited Statements of Accounts Issued by the Company.

Year ended Dec. 31st	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
Gross revenue (after deducting allowances to consumers) ..	£ 146,946	£ 175,792	£ 175,607	£ 187,253	£ 223,770	£ 250,080	£ 250,667	£ 242,886
Net revenue available for repairs and renewals, depreciation, reserve account, interest on debenture stock, &c., dividends and special charges	85,701	107,550	97,842	87,323	84,015	129,082	149,781	150,349

The directors have credited the debenture stock premium redemption account with £1,192 from revenue for interest, and the amount at the credit of the redemption account at December 31st last was £50,860. They have also transferred the sums of £45,000 and £500 from net revenue account to reserve account, thus raising the balance at credit of reserve account as at December 31st, 1903, to £219,642

in addition to which there are—

Debenture stock premium redemption fund ...	**50,860**
Amount carried forward to 1904	**21,882**
	£292,384

The appeals to the House of Lords were heard on May 14th last, and judgment was given on August 7th. The House of Lords affirmed the decision of the Court of Appeal that the two contracts for the Western and Central Districts of the City are invalid, and that the contract for the Eastern District is valid. As these appeals had in effect reference only to the public lighting of the main thoroughfares of the City, this decision of the House of Lords does not in any way affect the validity of the company's statutory powers for the supply of electricity for lighting and motive power to private consumers throughout the City. The company is still continuing the supply to the public street lamps as heretofore.

Chelsea Electricity Supply Co.

The directors' report for 1903 says that the profit for the year amounts to £33,055, which, with £312 brought forward, makes a total of £33,367. After deducting interest on debenture stock, £6,750; interim dividend 6 per cent. on preference shares, £900; interim dividend on ordinary shares at the rate of 4 per cent. per annum, £4,444; balance of interest, £63; amount written off suspense account, £1,607—£13,766, there remains a balance of £19,600, which the directors recommend shall be appropriated as follows:—

To credit of renewals and depreciation fund	£9,724
To final dividend on the preference shares at the rate of 6 per cent. per annum, making 6 per cent. for the year ..	900
To final dividend on the ordinary shares at the rate of 7 per cent. per annum, making 5½ per cent. for the year	7,776
Leaving a balance to be carried to the next account of ..	1,200
	£19,600

The efforts of the management have resulted in an increase of business, which has been accompanied by an actual reduction in the working costs. A further expenditure amounting to £3,026 2s. 7d. has been incurred during the year in connection with changing the system of supply from 100 volts pressure to 200 volts. This amount has been added to the suspense account, from which £1,607 has been written off, leaving that account at £3,213 1s. The directors have recently met the committee appointed by the founders' shareholders, and hope that some settlement in regard to founders' shares may be arrived at. It is, however, expected that a special Act of Parliament will be necessary to overcome the technical difficulties which at present beset a solution of the question. The number of lamps connected on December 31st, 1903, was 195,235, an addition of 19,233 during the year, and the improvement in the units sold per lamp continues. The total number of units sold in 1903 was 2,739,352, being 481,793 more than the previous year.

Telegraph Construction and Maintenance Co.

Sir Robert Herbert presided at the meeting of this company held at the offices on Tuesday. He said that the year 1903 had been a successful year for the company. They had succeeded last July in completing the laying of the second great Pacific cable that they had been concerned in, between Honolulu and Manila. It was 5,080 nauts, and the ships returned in very good order after contending against considerable difficulties at various points. One of the ships was able to pay its homeward expenses by taking some traffic which fell in its way. During the cricket test matches in Australia there was competition between two of this company's cables as to which should transmit the messages most rapidly, and they were very nearly equal. It was a record in rapid transmission, and it was all this company's work with the exception of an Atlantic portion of one of the cables. The board had now completed the pension scheme, and the item of £67,885 appeared in the report for the last time. That sum had now been invested in trustees for the purpose of forming a permanent fund for pensioning and granting gratuities to the employés of the company.

The solicitor having read the main heads of the pension scheme, the report and accounts were adopted, the dividend and bonus approved, and the pension fund trust deed sanctioned. The meeting closed with the usual vote of thanks.

South London Electric Supply Corporation.

The directors' report for 1903 shows that the total receipts for the year amount to £45,274, and the outgoings to £26,337. After placing the sum of £4,000 to depreciation, thus raising the depreciation fund to £6,448, and writing off £4,020 in reduction of preliminary expenses, there is a balance of £10,161. Out of this the board recommend the payment of a dividend of £3 per cent. per annum, carrying forward £411.

The directors have, during the past year, given careful and prolonged attention to the question of how best to deal with the item of preliminary expenses. Their view, in which they are supported by the opinion of counsel, is that this charge should be written off gradually, so as not to interfere with the payment of reasonable dividends to the shareholders in the meantime. They therefore recommend that the amount should be spread over a period of 10 years, and they have accordingly allocated for that purpose the sum of £4,020 for the first year. The same amount plus accrued interest at the rate of 3 per cent. per annum should be written off out of profits each year, until at the end of 10 years the item of preliminary expenses would disappear from the balance-sheet. The shareholders are asked by adopting this report to approve of the above arrangement. The plant, machinery and mains have been maintained in a high state of efficiency. The supply of power to the London County Council for working the tramways was commenced on May 15th last, and having been uninterruptedly continued since then, has considerably reduced the cost per unit sold. At the end of 1902, there were connected to the company's mains the equivalent of 72,601 8-c.p. lamps, at the end of last year these figures had risen to 91,902 8-c.p. lamps, being an increase of 19,301 lamps for the year, or over 26 per cent. At the present time the number on circuit is 92,321, besides which applications have been received for a further 5,000 lamps.

Statement of Electricity Generated, Sold, &c. (South London Electric Supply Corporation.)

Units generated.	Sold to consumers and used by public arc lamps.	Quantity utilised.		Quantity expended in distribution.				Total quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit, equivalent in 8-c.p. December 31, 1903.
		Used on works.	Total.	In batteries and motor alternators.	In feeders.	Transformers.	Total.			
5,478,272	4,805,481	174,410	4,979,891	128,780	52,419	240,511	421,660	5,401,551	76,721	91,902

Northallerton Electric Light and Power Co.

The annual meeting was held on the 24th ult., Mr. John Hutton, M.P., presiding.

The annual report showed a profit of £263, as compared with £152 last year. The directors had authorised the issue of 5,000 non-cumulative preference shares of £1 each, of these 563 have been already issued. £1,100 ordinary shares have been issued during the year.

The Chairman moved the adoption of the report, and hoped the shareholders would consider it fairly satisfactory, as compared with what had hitherto been placed before them. They had an improvement on profit and loss account of £145 12s., as compared with last year. They had sold 7,749 units of light more as compared with the previous year, of which 3,974 went to private consumers, and they had received the sum of £127 more for their current. The working expenses had decreased very considerably, viz., £51 11s., and they had saved on maintenance and repairs £47 17s.

Yorkshire Electric Power Co.

Mr. A. G. Lupton presided at the annual meeting held at Leeds on February 23rd. He moved the adoption of the report to Dec. 31st, of which we have already given an abstract. They had paid for the Thornhill Station site, and the Parliamentary cost of obtaining the Act and issuing capital amounted to £47,746. With a few additions the amount would be £48,000, which was well under the maximum figure of £55,000 stated in the prospectus. The wet weather had caused some difficulty to the contractors and delay, but the whole of the foundations and the main framework of the engine house were completed. The directors were opposing several Bills which were being promoted by local authorities for supplying electricity outside their own areas, as the powers, if granted, would allow direct competition with the company. By December next they hoped to be ready to supply electricity. The report was adopted.

Stock Exchange Notices.—The Committee has been asked to allow the following to be quoted in the Official List:—

Edmundson's Electricity Corporation, Ltd.—Further issue of £68,533 4½ per cent. first mortgage debenture stock (redeemable).

And has ordered the undermentioned securities to be quoted in the Official List:—

Electric Construction Company, Ltd.—Further issue of £12,500 4 per cent. perpetual first mortgage debenture stock.

Isle of Wight Electric Light and Power Company, Ltd.—£50,000 4½ per cent. debenture stock.

Hadfield's Steel Foundry Co.—The directors recommend a dividend of 20 per cent., making, with the interim dividend, 25 per cent. for the year. Twelve months ago the company increased its capital by £50,000, which was issued to the shareholders *pro rata* at £2 10s. per share, or £1 10s. per share premium. The directors will now ask the sanction of the shareholders to issue a further £50,000 on similar terms. The money is required for the further extension of the works, and will make the capital of the company £500,000.

W. T. Henley's Telegraph Works Co.—The directors recommend a dividend on the ordinary shares of 15 per cent. (less income-tax) for the past year, including the interim dividend of 6 per cent. paid September 1st last, payable March 12th.

Scarborough Electric Supply Co.—The report states that the number of consumers shows an increase upon the previous year, from 785 to 830, and that the total revenue had been £11,232, against £10,273. The accounts show a profit of £5,337, and after deduction of interim dividend at the rate of 2½ per cent., paid in August, the directors recommend a further dividend for the year of 4½ per cent., carrying forward £57. An agreement had been entered into with the Scarborough Electric Tramways Co. on lines satisfactory to both parties.

Underground Electric Railways Co. of London.—The Hon. Sydney George Holland has been elected a director.

Metropolitan Electric Supply Co.—A final dividend of 9s. 6d. per share, being at the rate of 9½ per cent. per annum and making a total distribution of 17s. 6d. per share, or 8¾ per cent. for the year, is declared, £18,000 has been placed to depreciation and reserve fund, and £2,485 carried forward.

The Charing Cross Co.—We understand that allotments are being made in full in respect of the recent issue.

STOCKS AND SHARES.

Wednesday Evening.

When business grows slack, members of the Stock Exchange turn to thoughts of reforming their own government. So to say that reformation is very much in the Stock Exchange air just now is to give a fair idea of the amount of trade being done. Money is plentiful, and the authorities talk it still cheaper, despite the war in the extreme East. This monetary factor, however, fails to exercise any inspiriting effect upon prices, since the public are becoming more and more convinced that whatever they buy "goes down," the consequence being that most people prefer to adopt a waiting attitude before distributing what capital they had on deposit with the banks at about 3 per cent.

British Electric Tractions slumped to nearly 9 the other day, but have recovered part of the fall, and show a loss of 10s. only on the week, at 9½. No explanation of the weakness is officially forthcoming, but in the Stock Exchange the view gains ground that as the British Electric Traction makes a good deal of its money by the promotion of new issues, and the times being so unpropitious for launching such undertakings, the parent must suffer as regards profits. Even the payment of the usual interim dividend at the rate of 6 per cent. per annum is questioned, and, with little inside support being extended, the presence of a few sellers of shares in such a market is sufficient to sensibly affect the price. On the point as to whether the decline may be expected to proceed still further, we can only say that the movement depends upon the action of the "Shop" to no small extent, since the public are clearly not buyers of investments, speculative or otherwise, at the moment.

Of the other traction varieties, London United Tramways Debenture is easier at 102½, but the Preference shares maintain their strength at 11½. The Ordinary have fallen a trifle to 17½. British Columbia Electric Tramway Deferred and Preferred are better at 84½ and 96½ respectively. Metropolitan Electric Tramways Deferred were the subject of some knowing buying at 4s. 6d., the low price of course underlining the fact that the shares are a speculation of the long-shot type. The Preferred shares are exactly £1, *ex* the recent dividend of 6d. Brisbane Electric Tramways Debenture stock has been done at 98½ and 98¾.

In the railway group, Central London Ordinary and Preferred are each a point to the good, but the Deferred keeps dull to 87½. City and South London Ordinary is by no means a bad market, and might easily add a few pounds to its price, there being some tendency to buy the stock, with which stock the market is none too liberally supplied. Waterloo and City, at 90½, is *ex* the 1½ per cent. dividend, and pays £3 6s. 6d. on the money at the present price, on the basis of 3 per cent. dividend, although taking 3½ per cent.—the distribution for 1903—there would be a yield of £3 9s. 1d. per cent.

Electric Lighting shares remain dull, and the movements this week are nearly all in the downward direction. Westminsters have recovered their dividend of 7s. deducted last week, and are still 13 middle, otherwise the changes are against holders London Electric Preference have fallen 15s. to 5, and the Ordinary ¼ to 1⅜, on the issue of the report. It is all very well to report progress in the development of business, but what should be attended to is depreciation, as well as dividend, and in this respect the London Electric Supply figures are sharply criticised. The Brompton and Kensington report, on the other hand, is one of the best that has been published, but no change has occurred in the price of the shares. The company's depreciation fund stands at £44,600, and the capital is only £200,000. Metropolitans are steady at 18, and no rise has followed the increase of the dividend from 7½ per cent. for 1902, to 8¾ per cent for last year. The company has manifestly experienced an excellent twelvemonths' trading, and we are glad to see substantial appropriations being made to depreciation and reserve. Chelsea Ordinary have eased ¼ to 5⅜, but here the directors are pursuing an eminently safe policy in paying no more than 5½ per cent. for 1903. Citys have not moved from 11, and Kensingtons show a trifling reduction when allowance is made for the dividend. Of the smaller shares, Blackheath Ordinary lost 2s. 6d., and are now ⅞, while Smithfields at 3¼ *ex* 4s. dividend, have moved down the fraction.

Idleness marks the Telegraph section. The Anglo-American Telegraph Co.'s group displays dividend-changes only, and Submarine Cables Trust certificates are down two points to 117½.

Eastern Ordinary came to market early in the week, and the result is a 2 per cent. drop to 119½. Great Northerns have again improved, and are ½ up, to 24, and Western Telegraph Debentures have risen to a point above par. The company declares a 3s. interim dividend on its shares, which stand at 12. National Telephone issues are dullish upon rumours of a new appeal for capital in Preferred stock and Deferred. The Chairman, of course, announced at the recent meeting that more money is wanted to cope with the increased business.

Henley's have not moved from 12½ upon the declaration of a 15 per cent. dividend for the past year, this including the interim dividend of 6 per cent. paid last September, and the manufacturing list, as a whole, is very quiet. Willans & Robinson Ordinary are a fraction down at 4, and the Preference, at 5½, are also easier on the week. Brush Second Debenture, at 75½, has fallen 2 per cent.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Feb. 24th.	Closing Quotations March 2nd.	Business done week ended March 2nd, 1904. Highest	Lowest
£7,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	.. — ..	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	6l8.	6l0/6	6l8.	50 — 53	49 — 52 xd	49	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	94 — 96	92 — 94 xd	93½	92½
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	7½ — 7⅝	7 — 7⅛xd	7⅛	7⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4½ — 5½	4½ — 5½	..	..
18,888,800$	Commercial Cable	$100	8 %	8 %	..	180 —190	180 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 91	89 — 91	90½	90½
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,981	Direct Spanish-Telegraph	5	4 %	4 %	..	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7⅛ — 8⅛	7⅛ — 8⅛	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101 %	98 —101%	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	9¾ — 10¼	9¾ — 10¼	10⅛	9⅞
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	119 —124	117 —122	121	118½
1,955,555	Do. 8½ % Pref. Stock	100	..	..	..	87 — 90	87 — 90	..	..
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	105	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10¾— 11¼	10¾— 11¼	11	10¾
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	98 —101	98 —101	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	101½	..
190,227	Globe Telegraph and Trust	10	5½%	..	..	8¼— 8¾	8¼— 8¾	8¼	..
190,042	Do. do. 6 % Pref.	10	..	..	..	12¼— 12¾	12¼— 12¾	12⅝	12¼
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	22 — 23	23½ — 24½	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	38 — 41	38 — 41	40	39⅜
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	103 —105	98 —100 xd	100¾	99½
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	78 — 81	73 — 76 xd	76⅝	74½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13½ — 14½	13 — 14 xd	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	13½ — 14½xd	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5⅜	5 — 5¼xd	5 1/16	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 97	95 — 97	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	100 —102	100 —102	101⅜	101½
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞ — 1	⅞ — 1	..	..
50,000	Do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6¾— 7⅜	6¾— 7⅜	..	..
8,808	Submarine Cables Trust	Cert.	..	..	..	117 —122	115 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾— 6	5¾— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅜— 5¼	4⅜— 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,809	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., I to 1,500 guar. by Brax. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
307,980	Western Telegraph, Ltd., Nos. 1 to 307,980	10	7 %	7 %	..	11⅜— 12¼	11⅜— 12¼	12⅛	11⅞
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,821	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
34,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4 — 5	4 — 5	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	87 — 91	87 — 91	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9½— 10½	9 — 10	10 1/16	9 1/16
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10½— 11½	10½— 11½	11	10⅝
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	122½	120½
100,000	British Insulated and Helsby Cables	5	10 %	10 %	..	6 — 6½	6 — 6½	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½— 5⅝	5½— 5⅝	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅝ — ¾	⅝ — ¾	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	½— 1	½— 1	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	1 — 1½	1 — 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	98 —101	96 — 99 xd	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80	75 — 80	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	..	10½— 11½	10½— 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 5⅜	5¼— 5⅜	5½	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 94	92 — 95	94⅛	93¼
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	96 — 99	97 —100	..	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	86 — 89	86 — 89	87⅛	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2¾%	49 — 52	49 — 52	51	50½
85,000	Crompton & Co., Nos. 1 to 85,000	5	7½%	5 %	..	1½ — 2	1½ — 2	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	96 — 99	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	¼ — ½	⅜ — ½	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1½ — 1¾	1½ — 1¾	1 1/16	1⅜
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	..	..	..	2½ — 3	2½ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½— 9¾	9½— 9¾	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	12 — 13	12 — 13	12⅞	13
35,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5½	5 — 5½	5 1/16	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	106 —110 xd	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18 — 19	..	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅛— 4⅜	4⅛— 4⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	9⅝— 10¼	9⅝— 10¼	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	33 — 36	33 — 36	34½	34½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	91 — 94	88 — 91 xd	90	89

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (continued).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations Feb. 24th.	Closing Quotations March 2nd.	Business done week ended March 2, 1904. Highest.	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	£ 1	..	..	..	⅜ — ½	⅜ — ½	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100				115 —118	115 118	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10 — 10½	10½— 10⅝	10⅛	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9⅝ — 10¼	9¼ — 10⅜	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	106 —109	106 —109	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7⅜ — 8⅛	7⅜ — 8	7 13/16	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5¼ — 5⅝	5⅜ — 5⅝	5⅜	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅜ — 5	4⅜ — 5	..	..
40,000	Do. do. 1903	5	..	..	..	4⅜ — 5	4⅜ — 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100				102 —104	102 —104	..	..
44,486	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	5½%	5¾ — 6¼	5¾ — 6	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock				106 —109	106 —109	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	5 %	10⅜ — 11⅛	10⅜ — 11⅛	11⅛	10⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid					121 —126	121 —126	..	..
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100				101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	..	8 — 9	7⅞ — 8⅝	8 1/16	7⅞
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11⅛ — 12⅛	11⅛ — 12⅛	..	..
400,000‡	Do. do. 4½% Deb. Stock					106 —109	106 —109	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock				99 —102	99 —102	100¼	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5⅜ — 6¼	5⅜ — 6¼	5⅝	..
90,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6⅜ — 6¾	5⅝ — 6¼	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	103 —106	103 —106	105	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 %	10 %	12%	11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	103 —106	103 —106	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅜ — 2⅛	1⅜ — 2	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅛ — 6	4⅞ — 5⅛	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock				95 — 98	95 — 98	97½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	8½%	17⅛ — 18⅛	17⅛ — 18⅛	18 1/16	..
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock					109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock				95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	6 %	13 — 14	13 — 14	13½	..
50 000	Do. do. 4 % First Mort. Debs.	100				99 —102	99 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3½ — 3⅝	3 — 3⅛ xd	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1½%	3 %	3¾ — 4⅛	3½ — 4	3⅝	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜ — 5	4⅜ — 5	4 1/16	..
80,000	Do. do. 5 % Cum. Pref.	5				4⅜ — 5⅛	4⅜ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	13½%	12⅜ — 13⅛	12⅜ — 13⅛ xd	..	..
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6⅛	6 — 6⅛	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, March 2nd.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric .. .. per cwt.	5/-	..
a	" Nitric .. .. per cwt.	22/-	..
a	" Oxalic .. .. per cwt.	32/-	..
a	" Sulphuric .. .. .. per cwt.	5/6	..
a	Ammoniac, Sal .. .. .. per cwt.	42/-	..
a	Ammonia, Muriate (crystal) .. per ton	£33 10	..
a	" " .. .. .. per ton	£30	..
a	Bleaching powder .. .. .. per ton	£4 10	..
a	Bisulphide of Carbon .. .. per ton	£15	..
a	Borax .. .. per ton	£13	..
a	Benzole (90 %) .. .. .. per gal.	7/-	..
a	" (50/90 %) .. .. .. per gal.	5/6	..
a	Copper Sulphate .. .. .. per ton	£23	..
a	Lead, Nitrate .. .. .. per ton	£24	..
a	" White Sugar .. .. .. per ton	£31	..
a	" Peroxide .. .. .. per ton	£27 10	..
a	Methylated Spirit .. .. .. per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C). per gal.	5/6	..
a	Potash, Bichromate, in casks .. per lb.	3d.	..
a	" Caustic (75/80%).. .. per ton	£24	..
a	" Bisulphate .. .. per ton	£35	..
a	Shellac .. .. per cwt.	200/-	20/- dec.
a	Sulphate of Magnesia .. .. per ton	£4 10	..
a	Sulphur, Sublimed Flowers .. per ton	£6 10	..
a	" Recovered .. .. per ton	£5 10	..
a	" Lump .. .. .. per ton	£5	..
a	Soda, Caustic (white 70 %) .. per ton	£10 15	..
a	" Crystals .. .. .. per ton	£3	..
a	" Bichromate, casks.. .. per lb.	2¾d.	..

METALS, &c.

b	Aluminium Ingots, in ton lots .. per ton	£130	..
b	" Wire, in ton lots .. per ton	£168	..
b	" Sheet, in ton lots .. per ton	£166	..
p	Babbitt's metal ingots .. .. per ton	£48 to £130	..
c	Brass (rolled metal 2" to 12") basis per lb.	6¾d.	..
c	" Tube (brazed) .. .. per lb.	8¾d.	..
c	" " (solid drawn).. .. per lb.	7¼d.	..
c	" Wire, basis.. .. .. per lb.	7d.	..
c	Copper Tubes (brazed) .. .. per lb.	9½d.	..
c	" " (solid drawn) .. per lb.	9¾d.	..
g	Copper Bars (best selected .. per ton	£70	..

METALS, &c. (continued).

g	Copper Sheet .. .. .. per ton	£70	..
g	" Rod .. .. per ton	£70	..
e	" (Electrolytic) Bars .. per ton	£63	..
e	" " Sheets .. per ton	£73	..
e	" " Rod .. per ton	£75	..
e	" " H.C. Wire per lb.	7⅞d.	..
f	Ebonite Rod .. .. .. per lb.	3/3	..
f	" Sheet .. .. .. per lb.	3/-	..
m	German Silver Wire .. .. per lb.	1/6	..
h	Gutta-percha fine .. .. per lb.	8/-	..
h	India-rubber, Para fine .. .. per lb.	4/5 to 4/5½	..
i	Iron, Charcoal Sheets .. .. per ton	£18	..
i	" Pig (Cleveland warrants) per ton	42/6	1d. inc.
i	" Forgings, according to size per ton	From £11	..
i	" Scrap, heavy .. .. per ton	47/6 to 50/-	..
i	" Wire, galvanised No. 8 .. per ton	£9 15	..
g	Lead, English Ingot .. .. per ton	£12 2 6 to £12 5	2/6 inc.
g	" Sheet .. .. per ton	£18	..
m	Manganin Wire No. 28 .. .. per lb.	8/-	..
g	Mercury .. .. per bot.	£8 5	..
d	Mica (in original cases) small .. per lb.	4d. to 1/6	..
d	" " " medium per lb.	2/6 to 3/9	..
d	" " " large .. per lb.	4/- to 7/9	..
p	Phosphor Bronze, plain castings per lb.	1/- to 1/2½	..
p	" rolled bars & rods per lb.	1/- to 1/3	..
p	" " strip & sheet per lb.	From 1/1	..
o	Platinum .. .. per oz.	£4	..
p	Silicium Bronze Wire .. .. per lb.	9d. to 11d.	..
i	Steel, Magnet, acc'd'g to desc'p'n per ton	£68	..
i	" " in bars	£15 to £40	..
g	Tin, Block .. .. per ton	£126 10 to £127 10	£1 dec.
g	" Foil .. .. per lb.	1/6	..
n	" Wire, Nos. 1 to 16 .. .. per lb.	1/7½	..
p	White Anti-friction Metals—		
	"White Ant" brand .. per ton	£12 to £62	..
j	Yarns, 2/10s Grey Cotton, on sp'ls per lb.	8d.	..
j	" 6 lea. Flax .. .. .. per lb.	5½d.	..
j	" 8 ply 10 lbs. Russian .. per lb.	4 1/2d.	..
j	" 10 lbs. Russian, single .. per lb.	4¼d.	..
j	" 180 lbs. Jute rove .. per ton	£11	..
k	Zinc, Sh't's (Vieille Montagne bnd.) per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

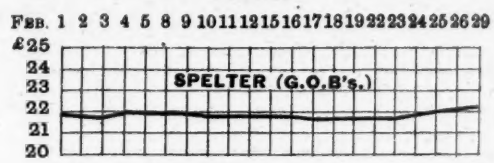
	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Aberdeen	Feb. 27	1,067	+244	99	47,327	+ 9,301	10	—
	Birmingham ..	" 27	4,976	+ 65	9	46,084	+ 2,846	3½	—
	Bournemouth ..	" 24	862	+ 26	—	47,961	—	10½	—
	Blackburn	" 26	734	+ 93	—	40,398	+ 2,021	13½	—
	Blackpool	—	—	—	—	—	—	8½	—
	" —Fleetw'd	" 27	168	— 43	9	1,529	— 81	7½	—
	" —Lytham	" 25	143	—	17	2,497	+ 1,918	7½	—
	Bolton	" 28	1,547	— 58	48	80,748	+ 8,977	25	—
	Bradford	" 28	3,332	+ 104	46	178,467	+ 22,736	78	+1
	Brighton	" 28	672	— 28	—	42,729	—	7½	—
	Bristol	" 26	4,358	+ 24	—	—	—	28	—
Co.	Devonport ..	" 19	419	+ 33	7	3,295	+ 497	5	—
	Dudley—Sto'rb'ge	" 19	732	+ 24	7	5,088	+ 206	18½	—
	Gateshead ..	" 19	844	+ 24	7	6,131	+ 242	10½	+ ¾
	Gr'n'k—Pt. Glsgw	" 19	458	+ 17	7	3,337	+ 467	7½	—
	Hartlepool ..	" 19	240	+ 18	7	1,741	+ 215	6½	+2
	Middleton	" 19	226	+ 1	7	1,700	+ 90	8½	—
	Oldham—Ashton ..	" 19	472	— 39	7	3,455	— 232	8	—
	Potteries	" 19	1,560	+ 86	7	11,358	+ 782	28½	—
	Southport	" 19	236	+ 9	7	1,681	+ 155	5½	—
	South Staffs. ..	" 19	720	+ 47	7	5,186	+ 344	21½	— ½
	Swansea	" 19	430	+ 21	7	3,061	+ 134	5½	— ½
	Wolverhampton..	" 19	834	— 22	7	2,298	— 85	10½	+8
	Yorks. Wool Dist.	" 19	488	+ 42	7	3,488	+ 422	6	—
	Miscellaneous ..	" 19	1,765	—	7	10,679	—	—	—
	Burnley	" 27	861	+195	—	—	—	10½	+3½
	Burton-on-Trent ..	" 28	275	—	30	10,278	—	8½	—
	Cardiff	" 20	1,804	+234	—	91,560	+22,772	1	—
	Chatham & District	" 25	475	+ 71	8	4,007	+ 871	8·58	—

* Compared with the corresponding period of 1903.

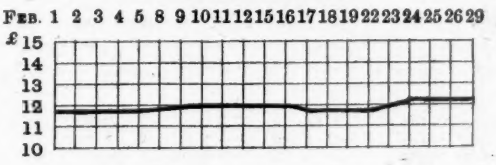
	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Cork	Feb. 25	367	— 19	8	3,117	— 2	9	—
	Dover	" 27	154	— 14	8	1,380	— 72	3	—
	Dublin	" 26	4,145	+ 16	9	35,185	+ 424	47	+ ½
	East Ham	" 27	598	+105	—	31,465	+ 2,578	5	+ ½
	Glasgow	" 27	12,997	+822	39	530,496	+53,349	69½	+5½
	Halifax (2 weeks) ..	" 24	2,113	— 29	47	62,295	+ 6,275	31½	+1½
	Huddersfield ..	" 20	1,119	+120	—	—	—	—	—
	Hull	" 27	1,895	+192	48	91,583	+ 7,279	18	+2
	Ilkeston	" 24	122	—	—	—	—	3½	—
	Ipswich	" 27	302	—	—	4,174	—	9	—
	Isle of Thanet ..	" 27	218	— 82	8	1,732	— 132	10½	—
	Leeds	" 27	4,763	— 137	—	269,818	+15,532	41	—
	Liverpool	" 20	9,257	+143	8	76,116	+ 2,886	109	—
	London C. C. ..	" 27	9,780	+1645	47½	468,450	+81,972	39½	—
	Manchester	" 27	10,578	+2456	—	652,180	+288,531	72	—
	Newcastle	" 27	3,823	+270	—	—	—	17	—
	Portsmouth	" 27	1,302	+109	—	82,004	+ 5,242	14½	—
	Salford	" 29	3,511	+ 678	—	187,351	+ 50,347	30	—
	Sheffield	" 28	4,091	+ 1	48½	218,098	+ 17,839	32½	+4½
	Southampton ..	—	—	—	—	—	—	16½	—
	Southend-on-Sea ..	" 24	229	+ 41	47	14,626	+ 2,215	8	—
	Sunderland	" 21	1,061	+ 91	47	58,504	+ 2,701	20	+8
	Tyneside	" 24	276	+ 36	8	2,160	+ 443	8·9	+ ·43
	Wolverhampton ..	" 28	353	— 3	—	—	—	5½	—
	Cen. London Rly. ..	" 27	7,138	+ 74	9	63,177	+ 480	6	—
	City & S. Lon. Rly.	" 29	3,127	+ 30	9	28,890	— 587	6½	—
	Dublin—Lucan Rly.	" 28	84	+ 28	9	780	+ 61	6½	—
	L'pool Overh'd Rly.	" 28	1,477	— 2	9	13,694	+ 356	6½	—
	Mersey Railway ..	" 27	1,377	+265	8	11,444	+ 2,810	4½	—

METAL MARKET.

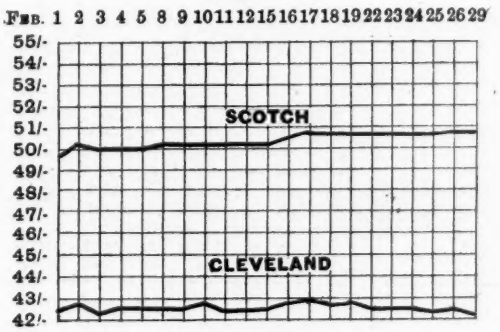
Fluctuations in February.



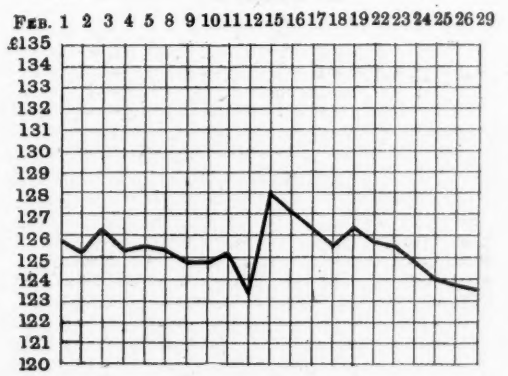
LEAD (ENGLISH).



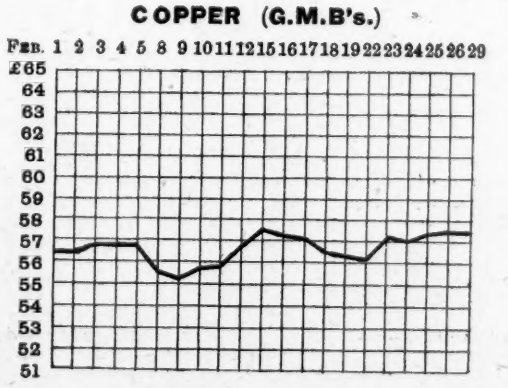
IRON.



TIN.



COPPER (G.M.B's.)



Lampeter.—The T.C. has decided to ask Prof. Ferrier, of the University, Bristol, to advise the Council as to installing electric light into the town.

NOTES ON THE CURTIS TURBINE.*

By F. SAMUELSON.

(*Concluded from page* 332.)

The good economy of turbines in general must be, to a great extent attributed to the very high degree of expansion of the steam which can be effectively obtained and utilised in the turbine. In ordinary steam engines a high degree of expansion is practically

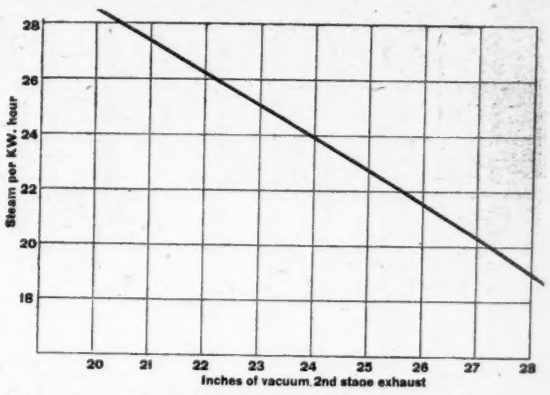


Diagram 1.—Steam Consumption under Varying Vacuum.
Curtis 500-kw. turbo-alternator. Load, 660 kw.; 1,800 r.p.m.; 150 lbs. pressure; 115° F. superheat; 30″ barometer.

impossible. As the exhaust pressure approaches a perfect vacuum the volume of the steam increases very rapidly, being twice as great at 29 in as at 28 in. To handle higher degrees of vacuum in an engine it would therefore be necessary to make the cylinders very

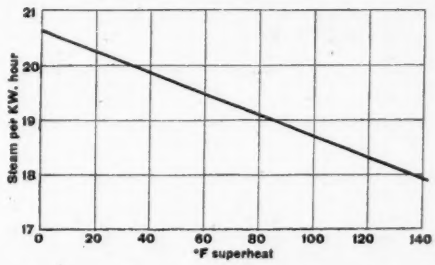


Diagram 2.—Steam Consumption under Varying Superheat.
Curtis 500-kw. turbo-alternator. Load, 660 kw.; 1,800 r.p.m.; 150 lbs. pressure; 28·5″ vacuum; 30″ barometer.

large and this increase in size and weight of parts, as well as the increased frictional losses, fixes a practical limit which cannot be passed without excessive cost and complication. In the turbine the highest degrees of steam expansion are easily provided for, and consequently a much larger proportion of the total work in the steam can be utilised by the turbine than by the steam engines.

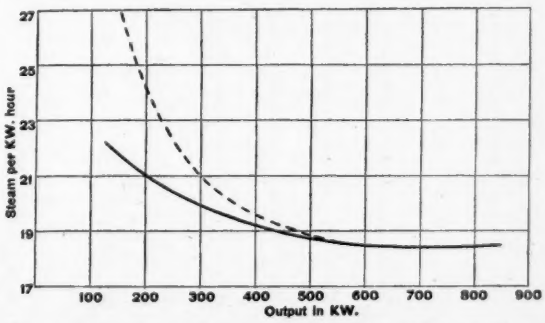
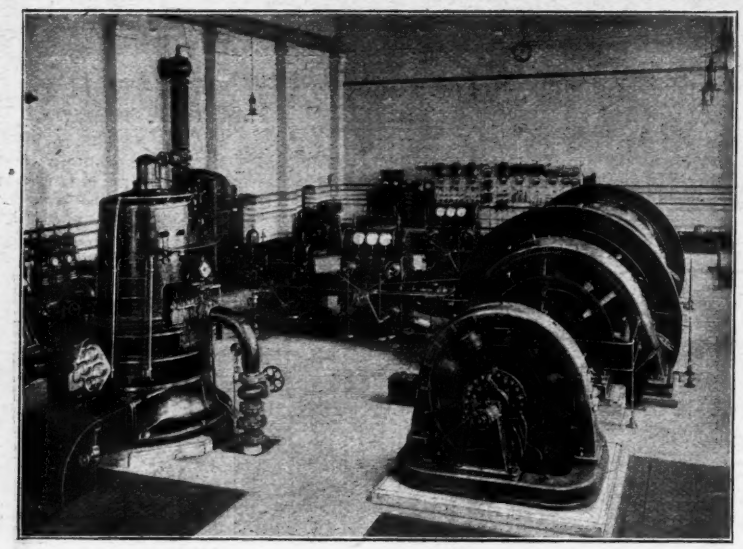


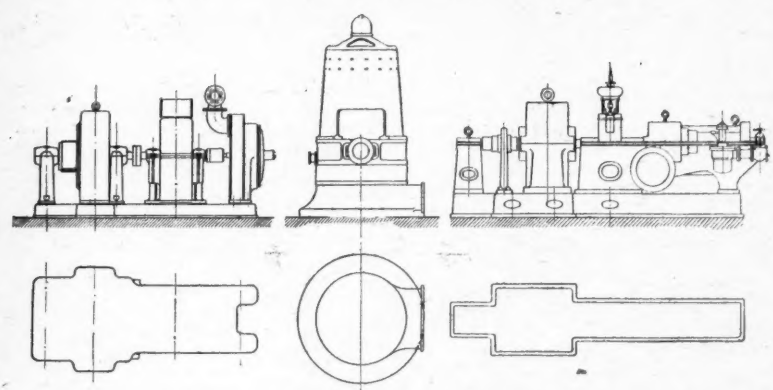
Diagram 3.—Steam Consumption under Varying Loads.
Curtis 500-kw. turbo-alternator. 1,800 r.p.m.; 150 lbs. pressure; 115° F. superheat; 28·5″ vacuum; 30″ barometer.

Diagram 1 shows the effect of different expansions or vacua upon the steam consumption. The curve is plotted from tests made on a 500-kw. turbo-generator in the B.T.H. Co.'s power house, and shows very clearly the enormous gain in economy with a high vacuum.

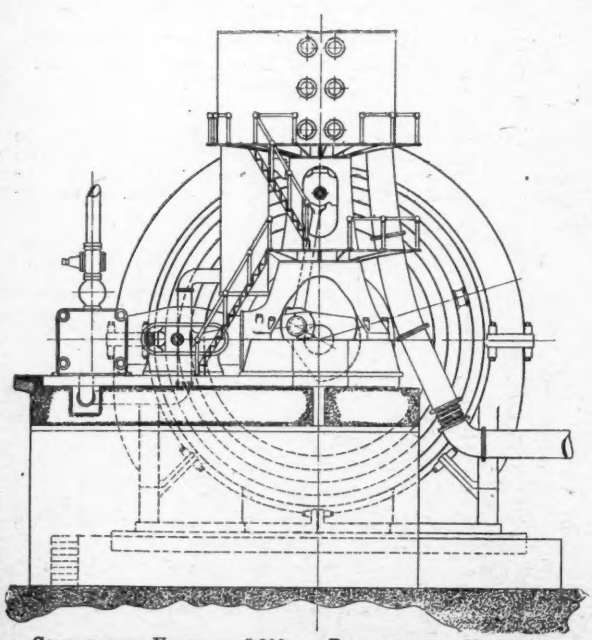
* Abstract of Paper read before the Rugby Engineering Society on November 5th, 1903.



British Thomson-Houston Co.'s Power Station at Rugby.
The Curtis Turbine, of 500-kw., is equal in capacity to that of the two sets shown and a third not seen in the view.



Comparative Sizes of 200-kw. de Laval, 500-kw. Curtis and 375-kw. Parsons Turbines.



Comparative Views of 5,000-kw. Reciprocating Engine, 75 r.p.m., and 5,000-kw. Curtis Turbine, 500 r.p.m.

No difficulties were encountered in obtaining a high vacuum. The outfit consists of an ordinary horizontal surface condenser with a cooling surface of 1,500 sq. ft., a twin Edwards air pump and a centrifugal pump for the circulating water. The pumps are motor driven, and the power taken by the air pumps was 1·8 kw., and by the circulating pump 7·1 kw. at a load of 470 kw. representing 1·9 per cent. of the output of the turbine.

The effect of superheat is shown in Diagram 2, and was obtained from tests carried out on the same turbine. With the conditions prevailing then, it was impossible to get a higher superheated steam for the turbine, but from tests made elsewhere on a Curtis turbine of the same output, the tendencies of the curve are shown to continue to about 300° F. superheat.

As indicated earlier in the paper, superheating improves the real thermal efficiency, or, in other words, reduces the coal bill. The probable reasons are the increased steam volume and that the steam being less wet after the expansion, the friction in the buckets is considerably reduced.

Diagram 3 shows a curve plotted, giving the steam consumption for different loads. To obtain a steady load on the generator, water resistance boxes were made use of, and careful readings of all instruments were made every sixth minute.

The condensed steam was delivered alternately to two tanks and weighed at six-minute intervals. All bye-passes were disconnected and all precautions taken to obtain absolutely reliable results, and the tests with different loads were repeated.

The flatness of this load curve is at once apparent, and it compares very favourably with similar curves obtained from reciprocating engines and other turbines. At the normal full load rating of 500 kw., the difference in steam consumption between full and half-load, you will note, is $1\frac{3}{4}$ lbs., and between full and quarter-load is $3\frac{1}{2}$ lbs. The 500 kw. rating for this turbine is, moreover, a very conservative one, and it could well be rated as 750-kw., that is, drive a 750 kw. generator. In that case, the load points would be located lower on the curve, and the difference in steam consumption still better, being between full and half-load only 1 lb., and between full and quarter-load 2·9 lbs.

The dotted curve line represents relatively, the average steam consumption from a number of first-class reciprocating engines of approximately the same rating as the turbine, and assuming the full load steam consumption to be the same for both. This comparison is very instructive, and shows how much more economical the turbine is on varying loads.

One of the great advantages arising from the use of the steam turbine is due to the entire absence of internal lubrication, thus making it possible to return the condensed steam directly to the boilers without the use of troublesome oil separators. Cost of oil and feed water is thereby lessened, and troubles arising from boiler scale and priming are reduced to the lowest possible limit. The cost of attendance should be small, as the turbine has only two glands or packings, requiring no lubrication, and one principal moving element, requiring no adjustment.

The only part of the turbine subjected to high pressure steam is the steam chest and its valves. Leaky joints are thereby greatly reduced. Even with very highly superheated steam, the buckets are not exposed to a high temperature, the heat of the steam being converted into velocity, while the steam passes through the nozzles, the temperature of the steam corresponding to the expanded pressure. The machine having no reciprocating parts, vibration is absent, and only very light foundations are required. This fact, together with the small amount of floor space occupied by the Curtis turbine, should materially reduce the cost of the station lay-out.

Another feature of considerable importance is the uniform turning moment obtained in the Curtis turbine by the continuous supply of steam to the buckets, and speed regulation by varying the volume thereof.

Water carried over from the boilers in large quantities does no injury to any part of the turbine, while many serious accidents to reciprocating engines are due to this cause.

The great saving in weight in the turbo-generator, as compared with the reciprocating engine and its separate generator, is not to be overlooked. Cost of handling in the shops, on transit and in erection, as well as the initial cost of production, is materially to the advantage of the turbo-generator. These few comparative indications sufficiently illustrate the improvement which the turbine has introduced, and I think we may confidently look forward to a bright future for the Curtis turbine.

In conclusion, I must express my thanks to the B.T.H. Co. for their permission to read this paper, and for the use of the drawings and curves.

RADIOGRAPHY, OR THE PRODUCTION OF AN IMPRESSION BY RAYS.*

With regard to the various rays (X rays, N rays, fluorescent rays, &c.) that are being so much discussed just now, Dr. D. Tommasi sends us a note in which he calls our attention to the fact that in 1886, *i.e.*, 10 years before Dr. Röntgen's splendid discovery relating to the X rays, he had succeeded in obtaining an impression on a photographic plate without the aid of light, and solely by the action of the dark rays. We give the note presented by Dr. D. Tommasi to the Académie des Sciences, Paris, on March 22nd, 1886:—

"I have the honour to submit to the Academy the first results of my researches on the means of obtaining solely by the action of electricity (dark discharge) the effects that are produced by the use of light in photography.

"In order to photograph objects without the aid of light, or to speak more correctly, to radiograph (effluviograph) them, I made use provisionally of the following apparatus:—Two metal brushes placed parallel to and facing one another, are each connected to one pole of a Holtz machine. A gelatino-bromide plate of about the same height is placed perpendicularly to the brushes in such a manner that the plane of the sensitised surface includes, or very nearly includes, the edges of these brushes at both ends. The current being established, an exposure of a few minutes only is sufficient. I need not repeat that this operation must be performed in total darkness. All that then remains to be done is to develop and fix by the ordinary methods the image obtained. This experiment tends to prove that the radiation produces the same effects as the ultra-violet rays, and that consequently there must be some connection between the two extremes of the spectrum, and that this connection consists in what I shall call provisionally, electric rays." (*Comptes Rendus* of the Académie des Sciences, March 22nd, 1886.)

To make sure that the electric discharge contains other rays besides the actinic rays, I made the following experiment:—

I laid on a gelatino-bromide plate a piece of printed paper in the form of a negative, and then placed the whole in a frame. The latter was wrapped up in such a manner that after having been exposed to the light for a certain time no change was produced; I was then certain that the wrapping was completely opaque, *i.e.*, that there was absolute protection from the luminous rays.

On the frame thus wrapped up, I produced a series of electric waves, the light from which, like the daylight, was unable to influence the sensitive plate. An action was produced, however, and the image obtained, developed and fixed, was similar to that which would have been produced by the action of luminous rays. We must, therefore, conclude that the electric light contains, besides actinic rays, the particular kind of rays that I have called electric rays, and the existence of which I have demonstrated by using dark waves (effluves), *i.e.*, waves denuded of luminous rays.

ROYAL COMMISSION ON LONDON TRAFFIC.

At the sitting of the Royal Commission on Thursday last week, Mr. J. W. Lowther, M.P., Chairman of the Committee of Ways and Means in the House of Commons, described the procedure adopted with regard to private Bills. He did not believe that Parliament would ever consent to handing over to an entirely independent tribunal the ultimate decision and control of such important matters as the routes, rates and conditions of the tube railways. He did not believe that important companies, capitalists, or public bodies would be satisfied with anything less than a Parliamentary decision. There were several objections to any tribunal or board laying down a general scheme for London. What might be well for 1904 might be obsolete, insufficient, or unnecessary in five or ten years' time, and should capital be invested in a scheme and the project prove financially disastrous, an overwhelming blow would be struck at the tribunal, and no capitalist was ever likely to trust to it again. The work of evolving a scheme which was to be reasonably permanent was beyond the power of any tribunal. It would involve engineering and financial investigations of vast magnitude, and entail a huge staff of highly-paid experts, engineers, electricians, legal advisers, draughtsmen, geologists, clerks and prophets. If, however, a tribunal was established to deal with tramways, omnibus routes, rules of the road, &c., tube railways might be placed under that tribunal to some extent. For instance, promoters might deposit draft provisional orders at the Board of Trade, and these could be sent, with any petitions, by the Board of Trade to the tribunal. The tribunal could decide all questions of the *locus standi* of opponents to take into consideration any report set by the Board of Trade, and the Board of Trade would from time to time introduce Bills confirming the provisional orders passed by the tribunal, and such Bills would go through the ordinary stages in the two Houses.

Mr. John Luthern Pound, a director of the London General Omnibus Co., Ltd., and chairman of the London Omnibus Owners' Federation, was then called. He said that it was desired on behalf of the London omnibus proprietors to show the great importance of their omnibus system, and to correct certain statements of previous witnesses as to the causes of congestion. The omnibus was the carriage of the people, and there was no other city in the world where the omnibus system was so complete as in London. The total capital involved in the trade amounted to several millions, and the employés to about 16,000. No less than 480,000,000 passengers were carried every year by London 'buses. The majority of passengers used an omnibus for a comparatively short distance, because they could get in and out of it at the exact places where they chose, and practically on to the pavement. Another point in favour of omnibuses was their mobility. In 1902 there were 3,696 'buses licensed in London as compared with 2,305 in 1892, and 1,389 in 1882. Continuing, witness said that omnibus proprietors were using their utmost endeavours to provide mechanical traction for these vehicles, and numerous forms of motors were constantly being submitted to them. It was only a question of time, and in all probability a short time, before a satisfactory motor would be produced. Dealing with the question of the congestion of the street, Witness said that it was the opinion of the omnibus proprietors that railways and deep level tubes were the best means, in conjunction with 'buses, of coping with the increasing traffic. With regard to the question of a tribunal, the omnibus proprietors suggested that such a body should consist of three or five members to be appointed for a number of years. As in the case of the Light Railway Commission, one of the members should be an engineer and one a lawyer. The members of the tribunal should devote the whole of their time to the work. He objected to the L.C.C. having a seat on the body so long as it remained a tramway authority. Witness then went on to deal with the question of Parliamentary procedure, and the Commission shortly afterwards adjourned.

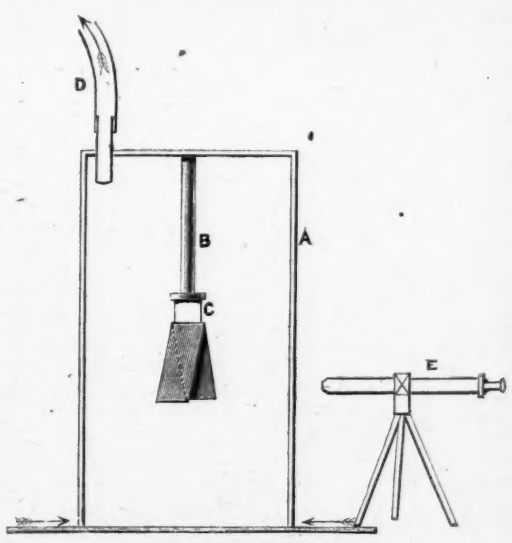
* "Effluves Obscurs."

ELECTRONS AND METEOROLOGY.

By JOHN DON, B.Sc.

Experiments have been made during the past month, at Peterhead Academy, Aberdeen, to discover the relative number of electrons present in the air under varying conditions of weather. The town is so situated that winds blowing from any quarter between N.N.W. and S. by W. travel over land, and all other winds are practically off the sea.

To attempt a correlation between weather conditions and the insulating qualities of the atmosphere would meantime be premature, but some remarkable results have already been forthcoming. Easterly winds, for example, as will be seen from the accompanying table, carry very few electrons, the insulation having been at times perfect for hours on end, in spite of the unmistakable dampness. Winds from the



The Electronscope.

west bring about a comparatively quicker discharge of an electrified body, and, so far, it would not appear that the amount of aqueous vapour has much to do with this action. January 26th was a good drying day, and yet the discharge was more rapid on that date than it had been since the 14th. It was also felt by many people to be a depressing day, and this also was to be remarked with regard to January 19th and 20th, although there was more vapour present on these occasions. An increase in the number of electrons would seem to have an appreciable effect upon the temperament, and possibly the vitality, of human beings.

Almost as much rain fell in the first week of February as during the whole of January, but yet the insulation of the atmosphere was far superior in the second month—

1 Date.	2 Duration of experiment.	3 Volume of air drawn.	4 Charge on leaves, + or −.	5 Fall in $\frac{1}{25}$th of mm.	6 Leakage when no air is drawn.	7 Barometer.	8 Thermometer attached.	9 Fall per $\frac{1}{10}$ cb. ft. in $\frac{1}{25}$ mm.	10 Dry bulb.	11 Wet bulb.	12 Wind direction.	13 Force of wind.	14 Clouds.	15 Remarks.
January 14	2 hr. 30 m.	5/10 cb. ft	−	23	—	28·050	47°	4·60	40	38·5	N.W.	Gale, 5	Overcast, some nimbus	Very wet.
„ 15	3 hr. 30 m.	8½/10 „	−	8	—	29·000	42°	0·95	35·3	32	N.W.	Very fresh, 3	Blue clouds, nimbus	Cold bright sunshine. Snow fall.
„ 16	2 hr. 30 m.	5/10 „	−	6	—	29·900	42°	1·20	33·2	32	N.W.	Fresh breeze, 2	Overcast	Snow.
„ 17	Sunday.					30·012	42·9°	—	37·3	34·9	N.W.	„ „	Nimbus	Cold. Thaw.
„ 18	3 hr. 30 m.	9/10 „	−	13	$\frac{1}{10}$ mm. in 2½ hours.	30·126	46·2°	1·44	43·0	41·8	S.	„ „	„	Dull. Wet.
Afternoon	3 hr.	6/10 „	−	11		rising slightly	„	1·83	50	48	N.W.	Very fresh, 3	„	„ „
Evening	1 hr.	3/10 „	−	3	—	30·2	„	1·00	„	„	„	„	„	„ „
January 19	3 hr.	6/10 „	−	4	Nil	30·354	48·5°	0·66	42·7	39·8	W.	Fresh breeze, 2	Clear	Fine weather.
Evening	2½ hr.	5/10 „	−	7	„	30·339	„	1·40	44	43	S.W.	„ „	„	Less pleasant than forenoon.
January 20	3½ hr.	8/10 „	−	3	„	30·425	49·2°	0·37	44·3	43	S.	2—calm	Blue to nimbus	Pleasant morning, showery evening.
Evening	5 hr. (3—8 p.m.)	3/10 „	−	4	„	slight fall	„	1·33	„	„	—	Calm	„	Showery, depressing.
January 21	1¾ hr.	4/10 „	−	3	„	30·356	40·9°	0·75	38·5	35·9	S.	Light breeze, 1·5	Cirro cumulus	Cold morning, but good day.
„ 22	2½ hr.	3½/10 „	−	3	„	30·462	46·7°	0·90	41	38·2	S.W.	Fresh, 2	Overcast	Dull.
Evening	2¾ hr.	3½/10 „	−	3	„	falling slightly	„	0·90	44·2	41·6	S.	Light, 1·5	Clear	Very good day.
January 23	1 hr.	2/10 „	−	3	„	30·318	45°	1·5	41	38	Calm	—	Blue	Good weather.
Afternoon	8½ hr.	No air dr'n.			$\frac{1}{25}$ mm. per hour.	30·240	„	—	41·8	40·1	„	„	„	„
January 24						30·074	46·5°	—	37·6	35·5	S.	Fresh, 3	„	Frosty.
„ 25	1½ hr.	4/10 cb. ft.	−	6	$\frac{1}{10}$ mm.	29·866	48·2°	1·50	35·4	33	S.	Light, 2	Overcast	Dull, but good day.
Evening	1 hr.	1½/10 „	−	2	„	29·818	„	1·33	40·3	38·9	S.	Fresh, 3	„	„ „
January 26	1½ hr.	3/10 „	−	9	$\frac{1}{25}$ mm. fall in 3 hours.	29·600	47°	3·0	42·5	40·2	S.S.W.	Very fresh, 3·5	Cirro cumulus	A good drying day, but several people felt dull and depressed.
„ 27	1 hr.	2/10 „	−	2	Nil	falling 29·180	48°	1·00	47	45·8	S.	„	Overcast	Gale in morning.
„ 28	4 hr.	7/10 „	−	2	„	29·068	48·8°	0·30	45·5	41·7	S.	Gale, 4	Blue to clear	High winds. Dew pt. by hygr., 5; temp. 8·5.
Evening	1 hr.	2/10 „	−	1	„	29·25 rising	„	0·50	41·6	38	„	„	„	„ „ „
January 29	2½ hr.	8/10 „	−	1	„	29·6 rising	47°	0·11	35	33	S. to S.W.	Fresh, 3	Blue	Good day. Dew pt. by hygr., 3·8; temp. 8·5.
Evening	1¼ hr.	2/10 „	−	½ to ¾	„	29·5 falling	„	0·34 (approx.)	43	39·7	S.	Gale, 4	„	Blowing hard.
January 30	2 hr.	4/10 „	−	3½	„	29·226 rising	„	0·87	44·8	41·8	S.	Gale, 3·5	Overcast	Dull; threatening rain.
Evening	1¾ hr.	5/10 „	−	3	„	29·23	46°	0·60	44·5	43	S.	Fresh, 3	„	Wind still S. on Sunday, 31st. Rain for whole of Jan. $\frac{66}{100}$ in.
February 1	¾ hr.	2/10 „	−	2—3	„	29·360	47°	0·87	41·1	39·2	S.E.	Blowing hard, 4	„	Wet; stormy; heavy rain.
	1½ hr., cont.	4/10 „	−	3½	„	„	„							
Afternoon	1 hr.	2/10 „	−	1	„	falling very slowly	„	0·50	41	39·8	E.	„ „	Cumulus	„ „
February 2	1¼ hr.	5/10 „	−	0	—	29·436	46°	0·0	42·5	39·9	S.E.	Fresh, 2·5	—	Storm all day.
Evening	1½ hr.	3/10 „	−	2	„	rising	„	0·66	41	38	E.	Gale, 4	Overcast	„
February 3	1½ hr.	4½/10 „	−	½ to 1	„									
	2 hr.	5½/10 „	−	1½	less than $\frac{1}{10}$ mm. per hour.	29·466	45°	0·11	40·2	32·2	E.	Fresh, 3	Clear	Slight showers.
„ 4	½ hr.	1/10 „	+	3	—	29·472	44°	3·00	38·2	36·2	N. to N.E.	Stormy, 4	Overcast	Rain.
„ 5	2 hr.	5/10 „	+	4	$\frac{1}{10}$ mm. in $\frac{3}{4}$ hour.	29·521	45°	0·80	40·8	39·1	E. to S.E.	Fresh, 2·5	Clear	Wet morning; good afternoon. Rain for five days Feb. $\frac{57}{100}$ in.

very possibly because the wind, as has been noticed, blew off the sea, and not from the land. Up to February 4th, the electroscope had always been charged with negative electricity, but on that day and subsequently, the wind continuing easterly, a positive charge was substituted. More rapid discharge was at once perceived, and in future observations will be made daily with both kinds of electrification.

The apparatus employed may be readily understood from the accompanying sketch—drawn to full size. The glass cell A, 12 cm. × 7 cm. × 7 cm., rests on a glass slab, and from the middle point of its cover depends a rod of sealing-wax, 5½ cm. long, B, from which two gold leaves, each 2½ cm. × 1 cm., are suspended by four single fibres of the finest silk, C. Air is admitted between the cell and the slab, and is drawn off by a filter pump to a meter not shown in the diagram. A reading microscope, E, is focussed on one of the leaves at a point near its lower margin. The electronscope, as this modified form of electroscope may be called, is charged to a definite potential by passing up from below a small proof plane which has been put in contact with the top of an ordinary electroscope whose leaves are divergent to a measured degree.

Air is drawn through at the rate of about $\frac{2}{10}$ cb. ft. per hour, and the duration of an experiment may be from one to four hours. The actual fall is recorded in $\frac{1}{25}$ths of a millimetre in Column 5, and the fall per $\frac{1}{10}$ cb. ft. of air drawn through in Column 9. The other columns contain collateral observations of barometer, &c., and for many of these I am indebted to Dr. MacWalter, Peterhead. I am also obliged to Mr. W. Crampton Smith, B.Sc., for his assistance in recording the observations.

The electronscope is my own device, and is superior to an electroscope, since it insulates almost to perfection, and is easily constructed, is obviously dust-proof, and can be charged with ease.

THE RIEDLER-STUMPF STEAM TURBINES.

By WALTER RAPPAPORT.

The heat energy of steam can be thoroughly utilised in steam turbines in different manners. First, the steam can be allowed to expand in conical nozzles, and then the kinetic energy be turned to account. The first steam turbine which utilised the steam in this way was the de Laval turbine. But theory proves to us that in such purely action turbines the circumferential velocity must be equal to half the steam velocity, which with the present customary pressure of at least 140 lbs. per square inch amounts to about 3,600 ft. per second, in reality even somewhat greater, as the angles of the vanes at the points of entrance and exit are not zero. In the Laval turbine this would, therefore, necessitate a circumferential velocity of 2,000 ft. per second, a moving wheel of about 20 in. diameter, making 30,000 revolutions per minute. These figures are practically not applicable, and so Laval was forced to gear down this high rotary motion of the wheel, whereby, of course, the economy was greatly diminished.

A one-wheel purely reaction turbine is out of the question, for the reason that here the circumferential velocity must be equal to the steam velocity, the number of revolutions, therefore, being twice as many as in the de Laval turbine. Parsons made use of the pressure in different stages, and in this way achieved satisfactory results, although the number of revolutions cannot be decreased *ad libitum*, as the application of a great number of stages would increase the internal friction greatly and make the machine extremely complicated. The latter drawback was removed by Rateau, who used but few stages, but let each wheel rotate in a closed chamber.

A third means of reducing the number of revolutions is by charging the steam with specifically heavier gases, as has been attempted by Escher, Wyss & Co. in Zürich. These trials were, however, unsuccessful, as it was impossible to completely regain the mercury vapours which were employed.

Recently Profs. Riedler and Stumpf have published turbine constructions which aim at reducing the number of revolutions as much as possible with economical utilisation of steam. First, they constructed wheels on the de Laval principle, but increased the diameter of the wheel considerably, up to 6·5—7·7 ft. diameter, so that the necessary circumferential velocity was attained without having to reckon with an enormous—practically impossible—number of revolutions. The wheels are constructed as massive nickel steel discs, the factor of safety being five. The wheels are balanced very exactly so that the centre of gravity is precisely in the centre of rotation. The bearings are, contrary to those in the Laval turbine, placed quite near the disc, and the blades not inserted singly, but milled like pockets in the rim of the wheel as shown in fig. 1. The pockets

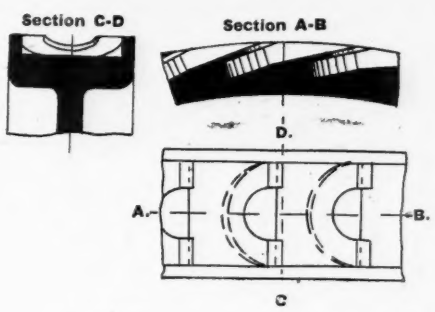


Fig. 1.—Blades of a Riedler-Stumpf Turbine.

may also be constructed in pairs, and then are similar in form to the buckets of a Pelton wheel. Whereas Laval employs at the most eight nozzles with elliptical outlet section placed singly, the Riedler-Stumpf construction has nozzles of rectangular section close to one another on the whole circumference of the moving wheel, so that the steam acts in a broad ring. The play between the stationary and moving parts can thereby be $\frac{1}{8}$ in. — $1\frac{1}{2}$ in., contrary to the Parsons construction. A turbine of the aforesaid construction of about 2,000-H.P. capacity is set up and working in the Moabit electric supply station of the Allgemeine Elektricitäts-Gesellschaft. The steam pressure is 200 lbs. per sq. in. absolute, at a temperature of 294° C., and the vacuum in the condenser is only 85 per cent. The wheel of this turbine weighs only 850 kgm., and is direct

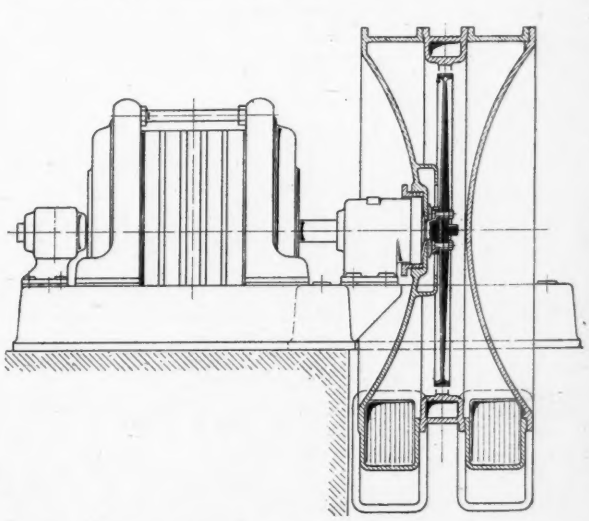


Fig. 2.—Riedler-Stumpf Turbine of 2,000 kw. Capacity.

coupled on the overhang of the heavy dynamo shaft, so that a simpler turbine can scarcely be imagined, and the mechanical efficiency amounts to nearly 100 per cent. Fig. 2 shows this turbine.

Instead of using the kinetic energy of the steam in one row of blades, it can be utilised in several wheels in succession. Only a part of the energy is used for the first wheel, this being easily achieved by suitably dimensioning the

angles of the vanes at the points of inlet and outlet, guiding over the steam to a second moving wheel, where it again loses a part of its energy, and then, if desired, to a third and fourth wheel. Too many velocity stages would injure the economy of the turbine, as the friction of the steam would then become too great. There are two methods of construction, to carry out this principle; the steam is either carried from the expansion nozzles over the first moving wheel, and from here by reversing guide blades back again to the same vanes, or the steam may be carried to a second wheel. The first construction is naturally the simpler and cheaper, but it only allows the steam to act on a part of the circumference. The second has the additional advantage of permitting the construction of the blades of both wheels with different angles, according to the steam velocity at these points. This type of turbine has already been built in sizes from 20—500 KW. by the A.E.G. The smaller constructions are well adapted to be placed on the boiler of a locomotive, where, in connection with a generator, they serve to illuminate the train.

A third turbine construction, having great resemblance to that of the American Curtis, has at the same time pressure and velocity staging. The steam expands in nozzles to a certain degree and then transmits its kinetic energy to diverse wheels in succession, it then comes to a second system of nozzles, expands there still more, and gains further velocity, &c., till its pressure has dropped down to the atmosphere or condenser pressure, and it has lost all velocity. The construction of the turbo-generator is shown in fig. 3. At A the steam

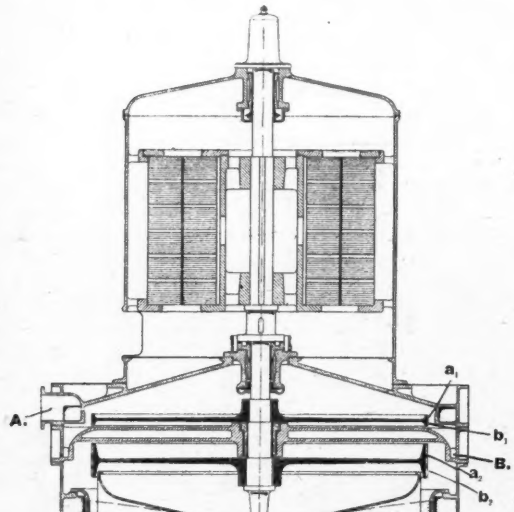


FIG. 3.—2,000-KW. RIEDLER-STUMPF TURBO-GENERATOR.

enters into the first nozzles and then impinges upon the moving blades a_1 and b_1. In this first pressure stage double velocity staging is applied. From b_1 the steam goes to the second nozzle system, B, the pressure drops down to the condenser pressure and the steam acts on a_2 and b_2. In all there are two pressure stages, each having double velocity stages used in the machine shown in fig. 3, which possesses a capacity of 2,000 KW.

A special feature of the Riedler-Stumpf turbines is the attaching of centrifugal jet-condensers to the turbine shaft itself. Such an apparatus is shown at C in fig. 3. The steam enters through the annular channel, d, from the last moving wheel, to the condenser wheel and mixes with the cold water coming in through pipe D. The mixture flows off through pipe E. Such an arrangement is, of course, not only possible with vertical, but also with horizontal construction, where, for instance, the turbine is overhanging attached to the one end of the dynamo shaft, and the condenser wheel to the other one.

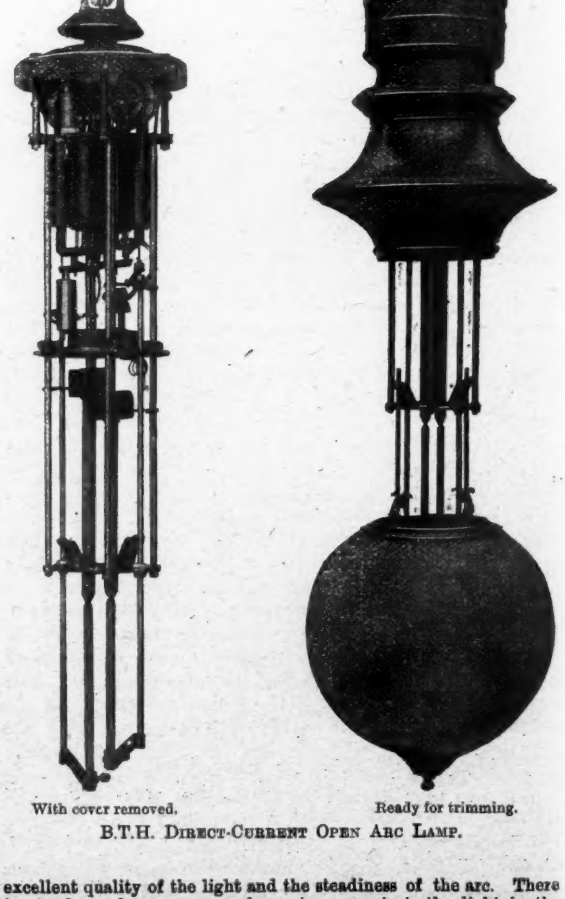
Another proposition has been made, to omit the reversing guide blades for velocity staging, and to replace them by wheels rotating in the contrary direction. The steam would, therefore, first expand in a nozzle, then lose a part of its velocity in revolving the first wheel, and act on a wheel running in the contrary direction, then again act on a third wheel running parallel to the first one and so on. The advantage would be that the steam would act on several wheels with less friction and in unchanging direction. In the construction, however, according to this principle, the admission and exhaust of the steam would involve difficulties.

Prof. Riedler in his paper read at the Berlin meeting of the Schiffbautechnische Gesellschaft (Society of Naval Engineers) gave some figures on the economy of his turbines, which, of course, admit of considerable improvement, as they are still in the first stages of development; notwithstanding this, remarkable results have already been attained as given in the following table:—

Where working.	Capacity.	Steam pressure lbs. per sq. in.	Condenser pressure lbs. per sq. in.	No. of revolutions.	Temp. Centigrade.	Steam consumption per KW.-hour.
Berlin Electric Supply Works	1,365 KW.	130	2·1	3,000	294°	19·6 lbs.
	1,920 H.P.	170	1·2	3,800	300°	17·4 lbs.
At half-load	850 KW.	116	9·2 % (vacuum)	3,000	290°	20·3 lbs.

B.T.H. DIRECT-CURRENT OPEN ARC LAMPS.

FOR street lighting in the business section of a city, many engineers consider that the continuous-current, open arc, focussing lamp is superior to the enclosed arc lamp, on account of the excellent quality of the light and the steadiness of the arc. There is a tendency for an open arc lamp to concentrate the light in the vicinity of the pole, and this is not objectionable when the lamps



With cover removed. Ready for trimming.

B.T.H. DIRECT-CURRENT OPEN ARC LAMP.

are installed at distances of 40 to 50 yards apart, as they frequently are for street lighting in large cities.

The British Thomson-Houston Co., Ltd., are now manufacturing at their Rugby works, a 10-ampere, open arc, continuous-current focussing lamp, combining all the latest improvements in electrical and mechanical design.

The brake wheel and feeding mechanism are of novel design, covered by patents. The brake wheel is made on the toggle principle, and is very positive in its action, while friction losses are kept at a very low figure. The casing, which is made of solid copper, with a black oxidised finish, is constructed in two parts which slide over one another. It is supported at the top on bayonet catches, and by removing one thumb screw the upper portion can be lowered, exposing the entire mechanism for inspection or minor repairs. For trimming the lower portion is raised, and the lamp can be trimmed by lowering the globe only 9 in.

When operating two or more lamps in series, it is necessary to have some means of adjustment in order to keep them burning with equal arc voltage. In the B.T.H. lamp this adjustment is made by shunting the series magnets with a high resistance adjustable coil. The adjustment can be made without turning off the lamp, and much closer regulation can be secured than with a mechanical adjustment.

All parts of the B.T.H. lamp are made by machinery, and are entirely interchangeable. The parts are designed to work together, without being so accurately fitted that their operation would be affected by the dust and dirt which always works into an arc lamp.

The lamp is so insulated that when the casing is on, no external part is in connection with the circuit. All the interior insulation is of mica or lava, and the insulation of each lamp is tested with 1,500 volts alternating current applied for 30 seconds.

The B.T.H. open arc lamp has a self-contained automatic cut-out, and is supplied with or without substitutional resistance, as required. External line resistances are used, depending upon the line voltage and the number of lamps in series. These line resistances can be supplied for mounting either on a wall or inside of the pole base, and can be made weatherproof when required.

The following data apply to the standard 10-ampere continuous current, double carbon, focussing lamp:—Arc voltage, 40 to 45. With normal arc voltage, the lamp will regulate within 5 per cent. Under normal conditions and with high quality carbons, the lamp will burn 30 to 32 hours with one trimming.

	Without substitutional resistance.	With substitutional resistance.
Dimensions :—		
With globe in place	51 in.	56½ in.
" " lowered	59½ in.	65 in.
Weights :—		
With globe and casing ...	53¼ lbs.	64¼ lbs.
Without globe and casing ...	33½ lbs.	44½ lbs.

TURBINES FOR LOW FALLS.

At the meeting of the Institution of Civil Engineers on February 16th, a paper was read by Alphonse Steiger, M.Inst.C.E., on "The Forms of Turbines Most Suitable for Low Falls." The following is an abstract of the paper:—

The author draws attention in the first instance to the character of water-powers with low falls. These are seldom constant, and in most cases both the fall and the water supply vary. The variations present an obstacle to the proper utilisation of such power, which, however, can be surmounted.

The prejudice against the utilisation of water-power with low falls, which constitute the majority of water-powers of the British Isles, arises principally out of the disregard of their peculiarities and the want of knowledge of the results which may be obtained from a specially adapted turbine under varying conditions, and is traceable to many unsatisfactory installations of absolutely unsuitable turbines.

The author then considers the difference between impulse turbines and pressure turbines, showing by a diagram that varying the portion of the fall used for producing pressure—that is, varying the degree of reaction, affords a means of adapting turbines to special requirements.

Pure impulse turbines are not altogether condemed for low falls, but places in which they are preferable to pressure turbines are extremely few in this country, and even the Haenel turbine, which is an intermediate type between the two, is not often suitable. An instance is given in order to show that such turbines, though excellent in themselves and efficient, do not necessarily make a satisfactory installation. The manner in which the disadvantage of all axial-flow turbines, namely, the influence of the angles of vanes varying with the radial width, which is particularly serious in impulse turbines, is partially overcome, is then explained.

The parallel-flow pressure turbine, generally known as the Jonval turbine, is mentioned as particularly adapted to greatly fluctuating falls, under which a constant speed may be obtained without sacrifice of efficiency. Such a turbine is described, which the author has installed for a fall of 2 ft., and particulars of tests made with similar turbines at the Zürich Waterworks are given, to show that the part-gate efficiency of parallel-flow pressure turbines of this kind is extremely good.

It is characteristic of the large majority of re-action or pressure turbines that their part-gate efficiency is low, particularly so at less than half-gate, which renders them valueless for varying conditions; but as in Europe the water-powers to be dealt with are chiefly of this kind, some European turbine builders have succeeded in designing pressure turbines which are giving a very satisfactory efficiency even at quarter-gate.

The conditions of the generation of electricity by water-power, such as high speed, rapid regulation, and concentration of large power in one unit, have influenced very considerably the art of building turbines. In the first place, the desire for high speeds has led to a more general adoption of radial-flow turbines, of which the inward-flow type is preferable, being the more efficient.

An example of radial-outward-flow turbines is cited, giving the special reasons which have led to their adoption in one case of a relatively low fall, and the manner in which a quite satisfactory efficiency was obtained from this otherwise less efficient type. One new type, the cone turbine, is referred to as taking the place of the so-called "mixed-flow turbines," with a view to obtaining a high speed under low falls, even for large units.

One important factor in turbines is the construction of the gate, and it is shown in the paper that a distinction must be drawn between gates intended for the adjustment of the turbine to a varying load, where a high part-gate efficiency is of less importance than rapid regulation, and gates for adapting a turbine to varying conditions, where a good part-gate efficiency is an essential condition.

Next, with special regard to electrical requirements, reference is made to the arrangement of several wheels on one common turbine shaft, vertical or horizontal, giving a few instances of the vertical arrangement which, under certain circumstances, is particularly advantageous, as the weight revolving on the footstep can be entirely balanced, and so the loss of power by friction is reduced almost to *nil*.

The necessity of placing the footstep of a turbine in an accessible position is alluded to, and the two kinds of overhead footsteps most commonly used are illustrated.

The author concludes by drawing attention to the necessity of studying more closely the conditions of water-powers with low falls, and of paying greater attention to more careful adaptation of turbines to such falls, which would probably lead to a better appreciation of the water-powers of this country.

ELECTRICAL FIRES.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

The very serious fires which have taken place in electricity stations, &c., call attention to the urgent necessity of Fire Brigade men being specially taught how to tackle an electric fire. At present, when a Fire Brigade see smoke issuing from a building, they pour volumes of water into it, which is just about the very last thing that should be done, if it is electrical. Recently, for example, smoke was noticed coming from a sub-station near London. It is probable that the trouble was quite local and could easily have been put right, but unfortunately the Fire Brigade got there first, and flooded the place, so making matters worse, not only for the sub-station but for the power station as well.

It looks as though special fire engines are required which will throw a jet of sand in place of water, and the writer commends the idea to Messrs. Merryweather. Another point in this connection is that it might be an advantage to have a large tank of sand in the roof over the switchboard, with a flexible hose pipe, so that the sand could be instantly turned on to a short-circuit. The mop as used at Deptford station for so many years may not always be effective.

One trouble in connection with electrical fires is that the fumes from burning insulation are so very dense and suffocating, and clearly the best method of curing this is to provide the cables with a kind of insulation which will not give off such fumes. Bare copper conductors might be used more frequently, and it is possible that a non-inflammable insulation, such as asbestos, could be developed.

Failing this, however, it would be well for engineers to investigate the relative merits of the insulations which are at present in use. Some give much denser fumes than others, whilst many of the bituminous compounds melt and ignite at quite a low temperature. Ordinary vulcanised bitumen, for example, will soften at 200°, melt at 300°, and give off fumes at 400° F. In this connection it may be mentioned that comparative tests have been made on Dialite and rubber cables, and the following is a summary of the principal particulars:—

A short length of cable insulated with Dialite, and another one covered with the same thickness of rubber, were heated in a retort in which special steps were taken to ensure the temperature being exactly uniform throughout. The behaviour of the two cables was as follows:—

Fah.	Cent.	Rubber.	Dialite.
311	155	Gives off fumes.	No change.
392	200	Fumes inflammable.	No fumes.
437	225	Fumes continue burning.	First fumes not inflammable.
464	240	Continue burning.	Fumes become inflammable.
518	270	Continue burning.	Continue burning.

A burning test was made by taking two cable ends each 1 ft. long with equal thickness of Dialite and rubber. They were suspended in a perpendicular position, the bottom end of each being ignited by two similar standard flames. The rubber, after the

removal of the flame, continued rapidly burning with an intense and ever increasing flame, the whole covering being burnt away in 7½ minutes, leaving the bare copper strand, whereas Dialite burnt with a very small flame which went out three times.

In a test to show the kind and quantity of fumes produced by Dialite and rubber, similar quantities of each material were placed in two separate and exactly similar volatilising dishes, the rubber in one and the Dialite in the other, great care being taken to ensure that the conditions in each case were exactly similar. Each of these dishes was covered by a draft funnel from which the fumes produced by similar standard burners were pumped into large glass cylinders.

The first stage of burning produced the same results in each case, but after a few seconds a thick, dense, palpable smoke began collecting on the bottom of the cylinder connected with the rubber. This continued rapidly increasing, and after a very short time filled the whole cylinder to the top. At this stage the cylinder into which the Dialite fumes were pumped with the same speed, was showing dense smoke only to a height of 1 in. from the bottom, the rest of the cylinder having only a slight veil of smoke.

In a few minutes' time the rubber fumes were produced so rapidly that the cylinder would not contain them, and they commenced burning outside and inside the funnel. Meanwhile, the Dialite showed nothing but a mere spasmodic flickering inside the funnel. After stopping the experiments, 100 grammes of rubber had been burnt to 35 grammes of ash, whilst the Dialite had lost only 20 per cent. of its weight.

It is possible that there are other insulating materials which are as much superior to Dialite in the above respects as Dialite is superior to rubber. If so, now is the time for manufacturers to set them forth. Nothing is too much to pay for absolute continuity of supply.

As a result of the Bristol fire, linoleum and rubber mats will, no doubt, be banished from switchboard platforms, and the writer would suggest in their place the employment of floor lights similar to those used in the Glasgow electricity works by Mr. Chamen and elsewhere. Being made with the glass cubes projecting above the iron framing, such a flooring forms a good insulator, and has the further advantage of giving light to the space under the switchboard platform. Slate slabs might also be used if an insulated flooring is absolutely necessary.

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

3,704. "An improved current collector for conduit electric tramways or railways and the like." C. P. Grew. February 15th.

3,722. "The Ajax, to be applied to electric trams and motor cars." F. H. Bostock. February 15th.

3,768. "Improvements in electrical heating and resisting apparatus." A. W. Penrose and M. Hankin. February 15th.

3,774. "Improvements in vapour electric lamps." H. I. Wood. (Date applied for under Patents Act, 1901, February 14th, 1903, being date of application in United States.) February 15th. (Complete.)

3,787. "Improvements in electric railway systems." A. A. Shobe and W. Embley. (Date applied for under Patents Act, 1901, April 10th, 1903, being date of application in United States.) February 15th. (Complete.)

3,790. "Improvements in and relating to electric furnaces." C. A. Keller. February 15th. (Complete.)

3,809. "Safety electrical cut-out." A. J. Fuller and M. H. Bennett. February 15th.

3,826. "Improvements in and in the manufacture of insulating or non-conducting materials for electrical purposes." Pontite, Ltd., and S. de Pont. February 16th.

3,840. "Improvements in controlling apparatus for electric motors." J. Klinkenberg. February 16th.

3,847. "Dynamo-electric machine." C. A. Allison. (The Hooven Owens Rentschler Co., United States.) February 16th. (Complete.)

3,884. "Improvements in alternating-current motors." The British Thomson-Houston Co., Ltd. (The General Electric Co.) February 16th.

3,885. "Improvements in electrical switching systems." G. Wright and F. V. Nicholls. (Date applied for under Patents Act, 1901, February 16th, 1903, being date of application in United States.) February 16th.

3,886. "Improvements in electric motor control systems." The British Thomson-Houston Co., Ltd. (The General Electric Co.) February 16th.

3,891. "Improvements in and relating to electrical energy meters." H. H. Lake. (R. Arno, Italy.) February 16th.

3,896. "Improvements in the method of and means for protecting apparatus on alternating current systems." C. H. Merz and B. Price. February 16th.

3,897. "Improved method of and means for protecting apparatus on alternating current systems of distribution." C. H. Merz and B. Price. February 16th.

3,912. "Apparatus for regulating electric current." La Societe L'Industrie Verriere et ses Derives. (Date applied for under Patents Act, 1901, February 17th, 1903, being date of application in Belgium.) February 16th. (Complete.)

3,918. "A process of and apparatus for the generation of electric energy." H. J. Keyzer. February 16th. (Complete.)

3,935. "Improvements connected with electric cable troughs or conduits." The Seacombe Pressed Brick and Tile Works, Ltd., W. H. Wilson and F. P. Jones. February 17th.

3,955. "Improvements in making and breaking contact with automatic electrical circuit breaker." W. Harrison. February 17th.

3,960. "An electrical automatic fog signal." T. J. Watkinson. February 17th.

3,979. "Clocks for regulating electric gas and other light." C. Rutherford. February 17th.

3,994. "Improvements in electrodes for arc lamps." A. C. Levis. (The General Electric Co., United States.) February 17th.

3,995. "Improvements in and relating to electric couplers." The British Thomson-Houston Co., Ltd., and A. S. Cubitt. February 17th.

3,996. "Improvements in electric conductors and methods of making the same." H. C. Levis. (The General Electric Co., United States.) February 17th.

3,997. "Improvements in electrodes for arc lamps." H. C. Levis. (The General Electric Co., United States.) February 17th.

3,999. "Improvements in arc light and electrodes and methods of making the same." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,000. "Improvements in arc lamp electrodes." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,001. "Improvements in electrodes for arc lights." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,002. "Improvements in arc light electrodes." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,003. "Improvements in arc light electrodes." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,004. "Improvements in electrodes for arc lamps and method of making same." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,005. "Improvements in electric arc lamps." H. C. Levis. (The General Electric Co., United States.) February 17th.

4,020. "Improvements in electric switches." A. C. Reyrolle. February 17th. (Complete.)

4,024. "Improved construction of apparatus for cleaning electrotypes and the like." A. Collis. February 17th. (Complete.)

4,034. "An improved electric terminal coupling for electric batteries or wires." A. S. Bright. February 18th.

4,059. "Improvements in and applicable to electric furnaces." W. Simm, H. Simm, R. Storey and J. S. Sellers. February 18th.

4,062. "A new type of electric arc lamp." G. Scialpi. February 18th.

4,075. "Improvements in supports for conductor rails of electric railways." H. L. Doulton and C. E. Morris. February 18th. (Complete.)

4,116. "Improvements in and connected with electrically controlled lifts and hoists." E. Chaudoir. February 18th.

4,133. "Improvements in arc lamps and electrodes therefor." H. C. Levis. (The General Electric Co., United States.) February 18th.

4,134. "Improvements in arc lamp electrodes." H. C. Levis. (The General Electric Co., United States.) February 18th.

4,167. "Device for colling electric sparking arrangements in internal combustion engines." R. Sanderson and J. Sanderson. February 19th.

4,168. "Improvements in or relating to the driving mechanism of certain classes of machinery, such as electrically driven cranes, hoists, and the like." W. Whitwell & Co., Ltd. and C. Demain. February 19th.

4,176. "Improvements in and relating to multiplex telegraphy." S. D. Field. February 19th. (Complete.)

4,188. "Improvements in or relating to electric accumulators or storage batteries." A. Blackman. February 19th.

4,181. "Improvements in electric traction systems." E. F. Moy and P. H. Bastie. February 19th.

4,219. "An improved pneumatic sound disc or diaphragm for telephones and other apparatus." A. J. Ridley. February 19th.

4,233. "Improvements in electrical switchboard appliances." G. K. B. Elphinstone. February 19th.

4,234. "Improvements in electrical measuring and indicating instruments." G. K. B. Elphinstone. February 19th.

4,252. "Improvements in or relating to the overhead wires or equipment of electric railways." N. S. Bertram. February 20th.

4,291. "Automatic and electric fire alarm acting under the principle of the dilation and contraction of the air or other gases." L. A. Carre. February 20th.

4,308. "Improvements in electrical ignition gear for explosion engines." W. A. Wilson. February 20th.

4,309. "Improvements in electric switches." The General Contracts Co., Ltd., E. S. Cook and W. H. Chipperfield. February 20th. (Complete.)

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Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

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Regulating Devices for Dynamo-electric Machines. H. H. Lake. (General Electric Co.) 16,904. July 30th.

Electro-magnetic Switches for Electric Railways. H. H. Lake. (General Electric Co.) 16,924.

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